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ORIGINAL ARTICLES.

I. — Woodwardian Museum Notes: A New Carboniferous Trilobite.

By F. R. Cowper Reed, M.A., F.G.S.

(PLATE X.)

AMONGST the fossils collected from the Pendleside Limestone of Butterhaw Knoll, Cracoe, Yorkshire, in which *Cyphaspis acanthina* (Coignou)[1] was discovered a few years ago, there are in the Woodwardian Museum a few specimens of a species of *Phillipsia*, which were found in 1889 by Professor Hughes' same geological party. My attention has been recently directed to them, and it has become evident, after a careful examination, that they do not belong to any of the hitherto described species of this genus. The characters of this new species, to which the name *Phillipsia cracoensis* is given, are as follows:—

Head-shield nearly semicircular; glabella regularly and gently convex, slightly elevated above the cheeks, cylindrical but narrowing a little in front of the eye-lobe. Anterior end of glabella rounded, not reaching front margin of head-shield, but separated from it by a narrow rounded border ornamented with a few concentric lines. Glabella marked off from neck-ring by a strong undulating neck-furrow consisting of a central portion arched forwards and oblique lateral portions bounding the basal lobes of the glabella.

Basal lobes of the glabella subquadrate in form, distinctly defined by furrows curving back towards the neck-furrow, before reaching which they become weaker. In front of the furrows defining anteriorly the basal lobes the glabella is marked by three pairs of furrows directed obliquely backwards. The posterior pair is the strongest and longest; the middle pair does not join the axal furrow; and the anterior pair, though invariably present, is very short, and in some specimens is represented merely by a pair of small pits.

Neck-ring broad and band-like, median portion averaging one-fifth the length of glabella and wider than first thoracic segment. Anterior part of lateral portion of neck-ring swollen on each side behind basal lobe to form a small low, elongated, triangular nodule,

[1] Quart. Journ. Geol. Soc., vol. xlvi (1890), p. 422.

with shortest side on axal furrow. Small median tubercle also present on neck-ring.

Facial suture cuts anterior border of head-shield almost at a right angle; from this point it curves backward and inward to the glabella, bending again outwards between the first and second glabella-furrows and defining a large, long, crescentic eye-lobe, at the base of which it turns sharply outwards and runs in an oblique direction to meet the posterior border of the head-shield at a very acute angle.

Eye-lobe extends from second furrow of glabella nearly to neck-furrow.

Free-cheek smooth, triangular, surrounded by raised rounded border ornamented with four or five raised concentric lines on upper surface. Genal angle obtuse, not produced into a spine.

Eye large, reniform, prominent, marked off from surface of free-cheek by encircling, broad, shallow groove. Surface finely facetted as in *Phill. gemmulifera*.

Thorax incompletely known. In one partly enrolled specimen seven segments of the axis are preserved which are attached to a head-shield. These segments are smooth and devoid of tubercles. The axis is gently convex, and very gradually diminishes in width towards the pygidium. The pleuræ in this specimen are unfortunately broken off, but were apparently about equal in breadth to the axis.

Pygidium semicircular, gently arched, edge smooth, slightly bevelled, without any marginal rim or grooved area. Axis prominent, rounded, rather more than one-third the width of pygidium, composed of twelve rings, each bearing an almost obsolete low median tubercle (scarcely visible on the posterior rings), with a lateral, stronger tubercle on each side, separated from the median one by a distinct, small, oval, striated patch, visible only in the cast. Axis extends a little over three-fourths the length of the pygidium, gradually tapering to its posterior end, which is obtusely pointed. A faint ridge slopes down with diminishing strength from the end of the axis to the margin of the pygidium.

Pleural portions of pygidium, forming area gently arched downwards from axis, marked on each side by 8–10 ribs, of which only the first three or four are distinct, the posterior ones being very faint and almost obsolete. The first furrow is strong and reaches the lateral margin of the pygidium; the second becomes weak before reaching the margin; the third is still weaker and shorter; the fourth is generally distinguishable in the cast, but those behind it are scarcely visible. The ribs are each marked with a central longitudinal groove, and each rib bifurcates at the weak fulcrum, which is situated about half-way along their length and is only perceptible in the first two or three ribs. These three first ribs reach the margin with distinctly bifurcated ends, but decrease in strength beyond the fulcrum. The posterior ribs, though much weaker along their whole length, are, nevertheless, traceable to the pygidial margin.

The actual surface of the pygidium is not preserved in its entirety in any of our specimens, but from isolated fragments of the shell attached to the casts the above features can be made out. A fine punctation is also noticeable on the surface with a hand-lens. The under surface of the pygidium is furnished with a broad infolded marginal portion ornamented with concentric striæ.

Hypostome elongate, obtusely pointed posteriorly; central portion convex, swollen, with subparallel sides; anterior portion most elevated, ornamented with several longitudinal lines, and provided with a narrow border marked off by a faint groove. Alæ subquadrate rather than triangular in shape, marked with irregular wrinkles, not separated from central portion of hypostome by furrow. Rounded narrow border surrounding posterior part of central portion behind alæ, but marked off from it by distinct groove. Lateral angles obtuse.

Measurements of Six Specimens of Head-Shields and Pygidia.

	mm.	mm.	mm.
Length of head-shield ...	11·5	11·0	9·0
Length of glabella	9·0	8·0	7·0
Width of glabella at base ...	7·0	6·5	6·0
Length of pygidium ...	11·0	10·0	8·0
Width of pygidium ...	16·0	14·5	12·0
Length of axis	9·0	8·0	7·0
Width of axis at front end ...	6·0	5·25	5·0

Affinities.—This new species, *Phill. cracoensis*, has wide affinities, but does not appear to be closely allied to any of the British species. The want of genal spines to the free cheeks recalls *Phill. derbiensis* (Martin), but in almost every other detail the head-shield is different, and the pygidium, moreover, bears no resemblance.

With *Phill. Colei* (McCoy) it agrees in the general shape and marginal characters of the pygidium, in possessing the same number of segments on the pygidial axis, and in the faintness of the pleuræ on the lateral portions. But it differs in the shape and ornamentation of the axis, and in the more strongly marked fulcrum and the bifurcation of the ribs. The head-shield is completely different, except in the relative size of the eyes; and the hypostome is narrower, has larger alæ, and a more strongly developed posterior border.

The general shape of the glabella and course of the facial suture are somewhat similar in *Phill. gemmulifera* (Phillips), but in all other respects the differences are marked. The three pairs of furrows on the glabella, in addition to the one marking off the basal lobe, recall *Phill. truncatula* (Phillips). But the pygidium shows little similarity.

From *Phill. Eichwaldi* (Fischer) our species is in most respects so completely different as to make any comparison needless. But a hypostome doubtfully referred to *Phill. Eichwaldi* by Dr. Woodward[1] is not unlike that of *Phill. cracoensis*, except in its less elongate form, less regularly convex axis, and triangular alæ.

[1] Mon. Brit. Carb. Trilob., p. 22, pl. iv, fig. 4.

The fewer glabellar furrows of *Phill. laticaudata* (Woodw.), the ornamentation of the axis of the pygidium, and the non-bifurcation of its pleuræ, compel us to regard this species as distinct, though it agrees in the shape of the pygidium and number of axial segments.

Phill. scabra (Woodw.) shows several points of resemblance, i.e., the non-elongation of the genal angles into spines, the striated border of the free cheeks, and the large eyes; but the shape and furrows of the glabella and the pygidium are quite different.

Phill. quadrilimba (Phillips) and *Phill. carinata* (Salter) are completely unlike *Phill. cracoensis* so far as they are known.

In *Phill. Leei* (Woodw.) the pleuræ of the pygidium are grooved, the neck-ring of the head is widest in the centre, the margin of the head is ornamented with parallel lines; but the eyes, the fixed cheeks, the glabellar furrows, and number of rings in the axis of the pygidium are different. *Phill. Cliffordi* (Woodw.), of which the head-shield resembles that of *Phill. Leei*, has bifurcated pleuræ in the pygidium, but there are thirteen rings on the axis, and these are unornamented. *Phill. minor* (Woodw.) has also bifurcated pleuræ on the pygidium, but fourteen unornamented segments on the axis and an entirely different head-shield. *Phill. articulosa* (Woodw.) shows no important points of resemblance, nor does *Phill. Van der Grachti* (Woodw.).[1] *Phill. Polleni* (Woodw.),[2] though agreeing with *Phill. cracoensis* in the shape of the pygidium, the faint pleuræ, and course of the facial suture, is in other respects unlike it, but Dr. Woodward considers it allied to *Phill. Colei*.

The pygidia on which the species *Griffithides? carringtonensis* (Ether. MS.) was founded resemble our new species in possessing twelve axial rings and grooved pleuræ, but differ in having a distinct flattened margin and absence of ornamentation.

Amongst foreign species there is none with which I am acquainted possessing any close affinity with this new one from Cracoe.

The points of resemblance of this species to the genus *Proetus*, which has been recorded from the Carboniferous System, though only doubtfully in the British Isles,[3] are of special interest. Dr. Woodward (loc. cit.) has clearly pointed out the affinities of *Griffithides*, *Phillipsia*, and *Proetus*, and this species seems still more completely to bridge over the gap between the two last genera, so that it is even possible to hesitate to which genus we ought to assign it. The features which indicate its very close alliance with *Proetus* are: (1) the course of the facial suture cutting the front margin nearly at a right angle, instead of curving inwards so as to cut it at an acute angle, as in the typical *Phillipsia*; (2) the presence of the small lateral lobes on the neck segment, which are distinctly recognizable, though obsolescent; (3) the few pleural furrows on the pygidium (when not decorticated); and (4) the presence of a distinct fulcrum on the anterior pygidial pleuræ. By these characters it is differentiated from all the species of *Phillipsia*, but the numerous other points of similarity to various

[1] Geol. Mag., Dec. IV, Vol. I (1894), p. 485.
[2] Ibid., p. 487.
[3] Woodward: Mon. Brit. Carb. Trilob., 1883, p. 55.

species of this genus, which have been described above, show that it is a generalized form, and suggest the idea that *Phillipsia* is separable as a distinct genus from *Proetus* more for stratigraphical than morphological reasons.

EXPLANATION OF PLATE X.

Fig. 1.	*Phillipsia cracoensis*,	n.sp.		Central portion of head-shield. × 3.
,, 2.	,,	,,	,,	Central portion of another head-shield. × 3.
,, 3.	,,	,,	,,	Pygidium. × 3.
,, 4.	,,	,,	,,	Another pygidium. × 3.
,, 5.	,,	,,	,,	Free cheek. × 3.
,, 6.	,,	,,	,,	Hypostome. × 3.
,, 7.	,,	,,	,,	Outline restoration of head-shield.

II.—On *Archanodon Jukesi* (Forbes MS.), Baily, sp., from the Old Red Sandstone of Monmouthshire.

By R. Bullen Newton, F.G.S.

Introduction.

THROUGH the kind intervention of Professor H. G. Seeley, F.R.S., some few years since, Mr. Percy Hawkins was induced to present to the Geological Department of the British Museum a slab of Old Red Sandstone from Llanvaches, nearly midway between Caerleon and Chepstow, Monmouthshire, containing some excellent impressions of *Archanodon Jukesi*.

Originally found in Ireland, and since reported from Northumberland, the present notice of the shell forms a second record of its occurrence in Britain. So far as our knowledge extends, it remains the most ancient lacustrine or fluviatile bivalve mollusc yet known in the British Islands, and on that account, coupled with its great rarity, it is hoped that the following account, dealing with its discovery in Western England, may lend an additional interest to the species. Before entering upon this, however, it may be of advantage to submit a brief summary of the literature relating to this organism.

Bibliographical Review of Archanodon Jukesi.

The first reference to this mollusc was made by Edward Forbes[1] in 1853 in a provisional list of fossils characterizing the 'Yellow Sandstone' at the hill of Knocktopher, co. Kilkenny, Ireland, which included plants (*Cyclopteris Hibernicus*, *Lepidodendron*, and *Stigmaria*), fish (*Hotoptychius*), Crustacea (*Pterygotus*), and a 'large bivalve shell,' to which was given the name of *Anodon Jukesi*. These forms of life were recognized as indicative "of fresh or at least brackish water conditions at the period of the deposition of the beds."

In 1857 J. B. Jukes and J. W. Salter[2] referred to the occurrence of *Anodon Jukesi* in the Yellow Sandstone of Kiltorcan Hill, near

[1] Edward Forbes, "On the Fossils of the Yellow Sandstone of the South of Ireland": 22nd Rep. British Assoc. for 1852, published 1853, p. 43.

[2] J. B. Jukes and J. W. Salter, "Notes on the Classification of the Devonian and Carboniferous Rocks of the South of Ireland": Journ. Geol. Soc. Dublin, vol. vii (1857), p. 63.

Thomastown, and at Tivoli Villa, near Cork, in association with plant remains, regarding the beds as belonging to the Upper Old Red Sandstone.

Later on in the same year Jukes[1] appears to have altered his opinion as to the age of the Yellow Sandstone Series of the South of Ireland, and considered them as of Lower Carboniferous age, a view which was supported by Sir Richard Griffith[2] in the following year (1858).

As a list name, W. H. Baily[3] in 1859 referred to this shell under the name of *Anodonta Jukesi*, recognizing its formation as Upper Devonian or Lower Carboniferous, although in the following year (1860) he[4] acknowledged the deposit as of Upper Old Red Sandstone age.

In 1861 Baily[5] invested the fossil with a greater scientific importance by publishing figures and a description. His account is as follows:—"The large bivalve shell, *Anodonta Jukesi*, Forbes, of which figures are given (reduced to half natural size), is rather abundant at Kiltorcan Hill, occurring with the plants before mentioned [*Adiantites* (*Cyclopteris*) *Hibernicus*, *Sphenopteris Hookeri*, *Cyclostigma*, *Lepidostrobus* ?]; no other mollusc having hitherto been found in those beds. It is clearly allied to the fresh-water mussels of the present day, being referred to an existing genus which is remarkable for the thinness of its shell and the absence of hinge teeth. Fig. 3*a* exhibits the exterior of this elongated shell, with its well-marked lines of growth, characters common to the existing fresh-water Unios and river mussels; 3*b* is from a cast of the interior of the left valve of a very large specimen; it shows the impression or cicatrice of the adductor muscle and the straight toothless hinge-line."

Another locality for the mollusc was noted by Baily[6] during 1864, viz. Gokane Point, Toehead Bay, co. Cork, where it was found associated with *Adiantites Hibernicus*; and in 1866 J. B. Jukes[7] recorded its discovery by Mr. Doran in the Old Red Sandstone of near Clonmel (Waterford).

[1] J. B. Jukes: "The Student's Manual of Geology," 1857, p. 441.

[2] Sir R. Griffith, "On the Remains of Fossil Plants discovered in the Yellow Sandstone Strata, situate at the base of the Carboniferous Limestone Series of Ireland, in connection with a Communication on that subject from M. Adolphe Brongniart": Journ. Royal Dublin Soc., vol. i (1858), p. 313.

[3] W. H. Baily, "On the Fructification of *Cyclopteris Hibernica* (Forbes) from the Upper Devonian or Lower Carboniferous Strata at Kiltorkan Hill, Co. Kilkenny": 28th Rep. British Assoc. for 1858, published 1859, p. 75.

[4] W. H. Baily, "On *Sphenopteris Hookeri*, a new Fossil Fern from the Upper Old Red Sandstone Formation at Kiltorcan Hill, in the County of Kilkenny, with some Observations upon the Fish Remains and other Associated Fossils from the same locality": 29th Rep. British Assoc. for 1859, published 1860, p. 98.

[5] W. H. Baily: "Explanations to Sheets 147 and 157 of the Maps of the Geological Survey of Ireland," 1861, p. 16, fig. 3.

[6] W. H. Baily, "Explanations to Sheets 187, 195, and 196 of the Maps of the Geological Survey of Ireland," 1864, p. 23; "Explanations to Sheets 192 and 199 of the Maps of the Geological Survey of Ireland," 1864, pp. 15, 17, 23.

[7] J. B. Jukes, "On the Carboniferous Slate (or Devonian Rocks) and the Old Red Sandstone of South Ireland and North Devon": Quart. Journ. Geol. Soc., vol. xxii (1866), p. 320.

As bearing upon the geological age of the fossil, reference may be made to Oswald Heer's [1] researches of 1872. This author regarded the Yellow Sandstone beds of Kiltorcan as of Lower Carboniferous age, after a comparison of its flora with that found in the Mountain Limestone of Bear Island. Further allusions to the species were published by Baily [2] in 1875, and another figure (copied from original illustration) was issued, but no new facts were made known.

Considerable interest was added to the subject by Richard Howse [3] in 1878, when he announced the discovery of this shell in the sandstone rocks of North Northumberland associated with *Ulodendron ornatissimum* and stems of *Calamites*. Its horizon he recognized as an upper member of the Tuedian group of the late Mr. George Tate, which he considered closely identical with the lower part of the Calciferous Sandstones of Scotland; further stating that "the supposed Upper Old Red Beds of Kilkenny will also no doubt be eventually and correctly correlated with these." In this account Mr. Howse established the new generic name of *Archanodon* for *Anodon* or *Anodonta*, as the shell had hitherto been called.

During the same year (1878) G. H. Kinahan [4] tabulated the Kiltorcan rocks containing *Anodonta Jukesi*, etc., as Lower Carboniferous. Mr. Howse [5] in 1880, as a correction of a priority dispute, again referred to the Northumberland form of *Archanodon Jukesi*, and mentioned a more precise locality for it than in his original account, viz., near Chillingham.

Dealing with the question of horizon, Professor Hull's [6] remarks of 1880 on the Kiltorcan rocks may be of interest to quote: "The occurrence of fish remains in the Kiltorcan Beds belonging to recognized Old Red Sandstone forms of Scotland and elsewhere, none of which ascend to the Carboniferous Series of other districts, places the relations of these beds to the Old Red Sandstone beyond question. The occurrence of *Anodonta Jukesi*, *Palæopteris*, fish, etc., all point to the fact that lacustrine conditions prevailed over this area of Southern Ireland during the deposition of these beds."

In the succeeding year Professor W. Boyd Dawkins [7] contributed

[1] Oswald Heer, "On the Carboniferous Flora of Bear Island (lat. 74° 30′ N.); and on *Cyclostigma*, *Lepidodendron*, and *Knorria* from Kiltorcan": Quart. Journ. Geol. Soc., vol. xxviii (1872), pp. 161–173, pl. iv.

[2] W. H. Baily, "On Fossils from the Upper Old Red Sandstone of Kiltorcan Hill in the County of Kilkenny": Proc. Royal Irish Academy, ser. II, vol. ii (1875), pp. 45–48. "Figures of Characteristic British Fossils: Palæozoic," 1875, p. 93, pl. xxxi, fig. 5.

[3] Richard Howse, "Preliminary Notice of the Occurrence of *Archanodon* (*Anodonta*) *Jukesi*, Forbes, in the Lower Carboniferous Rocks of North Northumberland": Nat. Hist. Trans. Northumberland, vol. vii (1878), p. 173, pl. xiv.

[4] G. H. Kinahan: "Manual of the Geology of Ireland," 1878, p. 78.

[5] Richard Howse, "Note on the Priority of Discovery of *Archanodon* (*Anodon*) *Jukesi*, Forbes, in the Lower Carboniferous Rocks of North Northumberland": Nat. Hist. Trans. Northumberland, vol. vii (1880), pt. 2, p. 376.

[6] Edward Hull, "On the Geological Relations of the Rocks of the South of Ireland to those of North Devon and other British and Continental Districts": Quart. Journ. Geol. Soc., vol. xxxvi (1880), p. 255.

[7] W. B. Dawkins, "On the Range of *Anodonta Jukesi*": Trans. Manchester Geol. Soc., vol. xvi (1881), pt. 11, p. 247.

Archanodon Jukesi (Forbes MS.), Baily, sp.

Upper Old Red Sandstone, Llanvaches, Monmouthshire. Reduced one-third less than natural size ; showing group of shells lying in matrix.

an interesting paper on *Anodonta Jukesi*, in which he compared the Irish and Northumberland habitats of this mollusc with the sandstone deposits of the Catskill Series of New York State, regarded variously as Upper Devonian or Lower Carboniferous, containing a large bivalve known as *Cypricardites Catskillensis*, and which he considered as a form closely analogous to *A. Jukesi*.

Professor Amalitsky[1] during 1895 established the new genus of *Palæanodonta*, selecting for his type *Unio castor* of Eichwald (Lethæa Rossica, 1861, p. 1,003, pl. xxxix, fig. 20), including in it, among other forms, *Anodonta Jukesi*.

Finally, it may be stated that the Monmouthshire specimen, now about to be described, was exhibited during the early part of 1895 at one of the meetings of the Geological Society of London,[2] and is referred to in the printed "Proceedings" as follows: "A specimen with *Anodonta* from the Lower Old Red Sandstone of Talgarth (Llanvaches), by Caerleon (Mon.), exhibited by Professor H. G. Seeley, F.R.S., on behalf of Percy Hawkins, Esq."

Description of the Specimen.

Genus ARCHANODON, Howse, 1878.

Nat. Hist. Trans. Northumberland, vol. vii (1878), p. 173, pl. xiv.

Type.—*Anodonta Jukesi*, W. H. Baily.

Synonyms.—*Anodon*, E. Forbes MS., 1853; *Anodonta*, W. H. Baily, 1861; *Amnigenia*, Hall, 1883; *Palæanodonta*, Amalitsky (*pars*), 1895.

Archanodon Jukesi, W. H. Baily.

Anodon Jukesi, E. Forbes: 22nd Rep. British Assoc., 1853, p. 43.

Anodonta Jukesi, W. H. Baily: 28th Rep. British Assoc., 1859, p. 75; "Explanations to Sheets 147 and 157 of the Maps of the Geol. Survey of Ireland," 1861, p. 16, fig. 3.

Archanodon Jukesi, Richard Howse: Nat. Hist. Trans. Northumberland, vol. vii (1878), p. 173, pl. xiv.

Palæanodonta Jukesi, W. Amalitsky: Quart. Journ. Geol. Soc., vol. li (1895), p. 346.

The remains of this shell as represented on the sandstone slab from Monmouthshire consist of two casts or moulds of the interiors of left valves and a fragmentary right one. They have apparently escaped compression during fossilization, the original convexity of the specimens being well preserved. The valves are elongate, subcylindrical, convex, and sloping from the lateral summit to the ventral margin at an angle of about 20 degrees; anterior area rounded and short, posterior produced and obtusely angulated from the beaks to the margin; the umbones are depressed, not prominent, and very anterior; the cardinal line is edentulous, straight, and elongate, extending to within about 40 mm. of the posterior margin; the pallial and adductor scar impressions are only very feebly seen

[1] W. Amalitsky, "A Comparison of the Permian Fresh-water Lamellibranchiata from Russia with those from the Karoo System of South Africa": Quart. Journ. Geol. Soc., vol. li (1895), p. 346.

[2] Quart. Journ. Geol. Soc., vol. li (1895): Proceedings, p. vii.

and almost incapable of proper definition, although the anterior adductor muscle impression is seen to be situated just beneath the upper margin of the shell, anteriorly and close to the umbone; surface ornamented at intervals with bold concentric growth-lines.

Dimensions. — Length, 140 mm.; height, 54 mm.; diameter (allowing for closed valves), 34 mm.

Remarks. — The privilege has been accorded the writer by Mr. J. Nolan, of the Geological Survey of Ireland, of examining the original specimen from Kiltorcan, to which Forbes gave the provisional name of *Anodon Jukesi*, and which Baily at a later date described and figured as *Anodonta Jukesi*. This type, as well as other examples of the shell from the same locality, has suffered more or less from lateral compression during the period of fossilization, so that the valves are much flattened and shallow, differing in this respect from the beautiful convex form of the species as exhibited in the sandstone impressions from Monmouthshire. Somewhat similar conditions have affected the valves of the closely allied species *Amnigenia* (*Cypricardites*) *Catskillensis*,[1] the only mollusc found in the Oneonta Sandstone (= Upper Old Red Sandstone) of Chenango Co., New York State, and Hall's remarks in connection therewith are of interest to quote: "The various phases of this species seem to be all due to the degree and direction of pressure during the process of embedding" (Palæontology; Lamellibranchiata: Geol. Surv. State New York, 1885, p. 517).

Another fact of interest regarding the valves from Monmouthshire is their association with fish remains,[2] although only in a comminuted state and quite beyond determination.

In Ireland the mollusc occurs with *Palæopteris Hibernica*, etc., *Coccosteus*, etc., and *Eurypterus Scouleri*?, etc.; in Northumberland with *Ulodendron ornatissimum* and *Calamites*; and in America *A. Catskillensis*, the close ally of the British species, is found in company with plant and fish remains (*Holonema rugosum*).[3]

All these facts demonstrate that the genus *Archanodon* was of lacustrine or fluviatile origin, and that the deposition of the beds containing it, whether in England, Ireland, or America, must have been regulated by similar physical conditions and in close proximity to land. A good deal of discussion has transpired as to whether these Upper Old Red Sandstone rocks should be regarded as Upper Devonian or Lower Carboniferous, and it is hoped that the Geological Survey Memoir now in progress on the Monmouthshire neighbourhood may finally determine this point.

Notwithstanding its intimate relations with the *Anodonta* of modern times, there can be no doubt as to the desirability of recognizing Mr. Howse's name of *Archanodon* for this ancient species, although it has been so singularly overlooked by palæontologists. Its adoption will necessitate the extinction of *Amnigenia*

[1] Examples of this mollusc are exhibited in the Geological Department of the British Museum.

[2] On the authority of Mr. A. Smith Woodward.

[3] See Dana's "Manual of Geology," 1895, ed. 4, p. 618.

of Hall, besides withdrawing the mollusc from the genus *Palæanodonta*, to which Amalitsky attached it in 1895.

The following dimensions of the known examples of *Archanodon Jukesi* and *A. Catskillensis* (largest specimens selected) may be of interest for comparison :—

Archanodon Jukesi.—Ireland : length, 185 mm. ; height, 75 mm. ; diameter (allowing for closed valves), 24 mm. Northumberland : length, 228 mm. ; height, 102 mm. Monmouthshire : length, 140 mm. ; height, 54 mm. ; diameter (allowing for closed valves), 34 mm.

Archanodon Catskillensis.—Length, 155 mm. ; height, 67 mm.

Horizon.—The Monmouthshire specimens are in a matrix of reddish-brown sandstone grit of a somewhat coarse character, highly micaceous, and with a tendency to pulverize when handled. This formation was probably of contemporaneous deposition with the 'Yellow Sandstone' Series of the South of Ireland, and may consequently be regarded as of Upper Old Red Sandstone age, and not of a lower horizon as originally surmised when the present specimen was exhibited at the Geological Society.

III.—Note on *Ammonites euomphalus*, Sharpe.

By G. C. Crick, F.G.S., of the British Museum (Natural History).

THE name *Ammonites euomphalus* was given by Sharpe[1] to an imperfect though unique specimen from the Lower Chalk, Man of War Cove, on the coast of Dorset. This example (according to Sharpe) originally belonged to E. H. Bunbury, Esq., but now forms part of the British Museum Collection [No. 50,158].

It is fairly well represented in the figures accompanying Sharpe's description, which is as follows :—"Shell gibbous, with a broad flattened back and angular whorls, crossed by numerous unequal tuberculated ribs, which bifurcate at the back; the ribs are about twenty in number on the side of the whorl, alternately larger and smaller; the larger ribs bearing a small tubercle near the umbilicus, and a strong spine at the edge of the back; the number of ribs on the back is about double that on the sides of the whorl, two springing from each spine, curving forwards and meeting again at the opposite spine; about every fourth dorsal rib is larger than the others, and bears two slight tubercles : umbilicus broad and funnel-shaped, leaving three-fourths of the inner whorls visible : aperture transverse and angular : septa with four very simple trifid, lateral lobes, and the lateral saddle very small."

As mentioned by Sharpe, the shell is "crossed by numerous unequal tuberculated ribs . . . . alternately larger and smaller . . . . the larger ribs bearing a small tubercle near the umbilicus, and a strong spine at the edge of the back," but the smaller ribs also have tubercles similarly situated, though relatively very much smaller than those on the larger ribs. The pairs of ribs which pass across the periphery and connect the strong spines on

[1] D. Sharpe: "Foss. Moll. Chalk of England" (Mon. Pal. Soc.), pt. ii (1854), p. 31, pl. xiii, figs. 4*a-c*.

one side with those on the opposite side are thicker than the rest, the posterior one of each pair being the thicker of the two; this is especially the case where the diameter of the shell is 10 mm. At the middle of the periphery each rib bears a very feeble tubercle; on each side of this and about half-way between it and the large lateral spine, there is another rather more prominent, but still feeble, tubercle. The tubercles on the thickened ribs, especially on the posterior one of each pair connecting the large spines, are relatively larger than the rest.

Sharpe gave the dimensions of the type-specimen as follows:—Diameter, three-fourths of an inch; width of aperture, half an inch; height of the last whorl, one-third of an inch. My own measurements of this specimen are:—Diameter of shell, 21·5 mm.; width of umbilicus (at suture of shell), 8·5 mm.; height of outer whorl, 8 mm.; height of outer whorl above preceding whorl, 6·5 mm.; thickness of outer whorl, 10·25 mm.

In 1896 Mr. A. J. Jukes-Browne recorded,[1] but did not figure, an example of this species from the "sandy chalk, Bed 13 of Mr. Meÿer, in the cliff below Whitlands coastguard station, west of Lyme Regis." This specimen belongs to the Survey collection at Jermyn Street Museum, and is represented in the accompanying figures (Figs. 1*a*–*c*). It is completely septate, and has a diameter

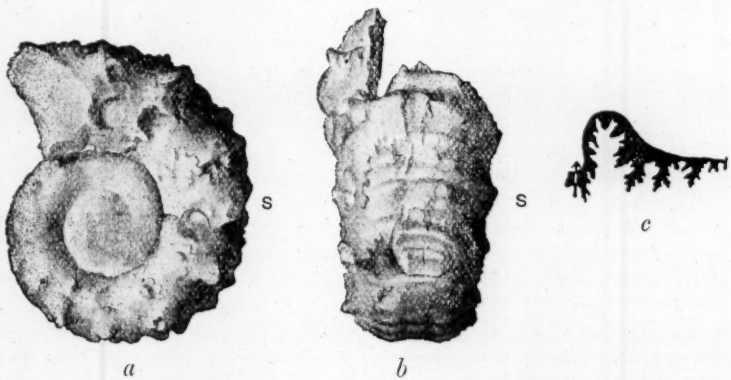


Fig. 1.—*Douvilléiceras euomphalus* (Sharpe).—*a*, lateral view; *b*, peripheral view of the same specimen; *c*, suture-line of the same example as seen at the place marked *s* in *a* and *b*. From "sandy chalk, Bed 13 of Mr. Meÿer, in the cliff below Whitlands coastguard station, west of Lyme Regis." Drawn of the natural size from an example in the Museum of Practical Geology.

of 40·5 mm., being therefore much larger than Sharpe's type-specimen. Owing to the imperfection of the anterior part of the fossil its dimensions can be best taken at a diameter of 38 mm. These are:—Diameter of shell, 38 mm.; width of umbilicus (at suture of shell), 15 mm.; height of outer whorl, 14·5 mm.; height

[1] Quart. Journ. Geol. Soc., vol. lii (1896), p. 155.

of outer whorl above preceding whorl, 13·5 mm.; thickness of outer whorl (excluding spines), 21·5 mm. The specimen is fairly well preserved; the inner whorls are, however, imperfect on one side, and on the other obscured by matrix if present. The suture-line is displayed where the fossil has a diameter of 33 mm.; it is represented in Fig. 1*c*. One side of the earlier portion of the outer whorl bears marks of an injury during the life of the animal.

So far as I know, these are the only two examples that have been recorded as belonging to this species.

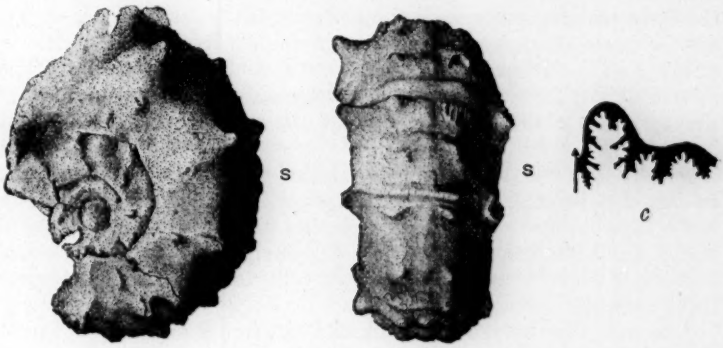


Fig. 2.—*Douvilléiceras euomphalus* (Sharpe).—*a*, lateral view; *b*, peripheral view of the same specimen; *c*, suture-line of the same example as seen at the place marked *s* in *a* and *b*. Lower Chalk: Humble Point, close to Whitlands, west of Lyme Regis. Drawn of the natural size from the example in the British Museum (Nat. Hist.) that was collected and presented to the Museum by Dr. Rowe and C. D. Sherborn, Esq.

Among some Chalk fossils recently collected by Dr. Arthur Rowe, F.G.S., and Mr. C. Davies Sherborn, F.G.S., from the "hard nodular Cenomanian Limestone with grit and green grains, half a mile from the shore at Humble Point, close to Whitlands (west of Lyme Regis), Devonshire," there is a specimen which I consider to be referable to Sharpe's species (see Figs. 2*a*–*c*). Being entirely septate, and therefore incomplete, it does not furnish the characters of the adult shell; nevertheless, it is a particularly interesting specimen, for being larger than either of the previously recorded examples, the characters which it displays more nearly approach those of an adult shell. A portion of the outer whorl is missing, but the rest of the fossil is well preserved; the inner whorls are present, and the suture-line is shown. The dimensions of the specimen are:—Diameter of shell, 43 mm.; width of umbilicus (at suture of shell), 16 mm.; height of outer whorl (excluding spines), 16 mm.; height of outer whorl above preceding whorl, not seen; thickness of outer whorl (excluding spines), 23 mm. The inner whorls up to a diameter equal to that of Sharpe's type-specimen can be plainly seen; they are fairly well preserved. The

shell passes from a diameter of 21·5 mm.—the diameter of the type-specimen—to its greatest diameter, viz. 43 mm., in about three-fourths of a whorl. The first fourth of this portion is wanting. The last half-whorl is well preserved; on its lateral area the smaller ribs completely disappear, while the spines on the larger ribs become relatively larger, the inner one only slightly, but the outer one considerably. The pairs of strong ribs on the periphery connecting the large lateral spines are well developed. Of the tubercles on the anterior rib of each pair, that on each side of the median line of the periphery becomes with age relatively much smaller, while the corresponding tubercle on the posterior rib becomes much larger, the rib itself becoming at the same time much less distinct; the rib at the anterior lateral spine that is preserved is very feeble. The intermediate ribs almost entirely disappear at the anterior part of the specimen; the tubercles on the rib which is situated about half-way between two lateral spines gradually increase in size, especially the one on each side of the median line, that on the median line being well marked, but smaller and more obtuse than the others. With considerable difficulty the suture-line has been traced on this portion of the fossil, namely, at the point marked *s* in Figs. 2*a*, *b*, where the diameter of the shell is about 34 mm.; it is represented in Fig. 2*c*.

Although this specimen considerably increases our knowledge of Sharpe's species, we are not yet in a position to give the characters of an adult shell.

As will be seen from a comparison of Figs. 1 and 2, there are certain differences between the originals of the two figures. A very obvious difference is in the number and size of the lateral spines. The example represented in Fig. 2 has fewer and relatively stronger spines than the original of Fig. 1; the former has only five large lateral spines in the last half of the outer whorl, whereas the latter has twelve large spines in the outer whorl, seven of these being in the last half-whorl. Unfortunately the inner whorls of the example represented in Fig. 1 are not well preserved, but their ornaments seem to agree very closely with those of the type-specimen, the spines on the inner whorls of the original of Fig. 2 being relatively further apart. There are also differences between the suture-lines of the two specimens; some of these may be due to the spiny character of the shell, the suture-line varying somewhat according to the position of the septum with regard to the spines. The specimens were, however, found at the same locality and on the same horizon; hence, notwithstanding the differences just mentioned, we are inclined, in the absence of more satisfactory material, to refer these examples to the same species, the example depicted in Fig. 1 being probably more like the adult of Sharpe's type than the original of Fig. 2.

In regard to the affinities of this species, Sharpe correctly pointed out that it was allied to *Ammonites Martinii*, D'Orbigny,[1] a species

[1] A. d'Orbigny: Pal. Franç. Terr. Crét., vol. i (1841), p. 194, pl. lviii, figs. 7–10.

belonging to the group for which Grossouvre has proposed the generic name *Douvilléiceras*,[1] the type species being *Ammonites mammillatus*, Schlotheim.[2] It is evidently closely allied to the *Acanthoceras aberrans* of Kossmat,[3] who regarded that species as an aberrant member of the genus *Acanthoceras*. That species appears to be very rare, for only a single example is known, and that came from the Middle Utatur Group of Odium, South India—a group containing numerous *Acanthoceras* of the group of *Rothomagense*, Defrance, and *Mantelli*, Sowerby, as well as *Turrilites costatus*, Lamarck, etc., and referred by Dr. Kossmat to the younger portion of the European Cenomanian. Neumayr[4] referred the present species to his genus *Hoplites*.

There can, we think, be no doubt that this species is closely allied to the genus *Douvilléiceras*, and we think it may be placed, at least provisionally, in that genus. Sharpe's type-specimen came from the Lower Chalk, Man of War Cove, on the coast of Dorset, but the Cephalopoda occurring in association with it are not recorded. From the bed in Devon which contained the example of this species referred to by Messrs. Jukes-Browne and Hill, these authors record the following Cephalopoda (the species marked S having been collected either by themselves or by Mr. Rhodes for the Geological Survey, and those marked M having been identified by Mr. Meÿer from specimens in his own collection) :—

Belemnitella plena, Blainville	S M
Nautilus Fittoni, Sharpe	S
,, *Deslongchampsianus*, D'Orbigny	M
Ammonites euomphalus, Sharpe	S
,, *Goupilianus*, D'Orbigny	M
,, *hippocastanum*, J. de C. Sowerby	S M
,, (?) *leptonema*, Sharpe	M
,, *navicularis*, Mantell	S M
,, *pentagonus*, Jukes-Browne	S
,, *planulatus*, J. de C. Sowerby	M
,, *Renevieri*, Sharpe	M
,, *rothomagensis*, Defrance	S M
Scaphites æqualis, J. Sowerby	S M
,, ,, var. *obliquus*, J. Sowerby	M
Turrilites Bechei, J. Sowerby	M
,, *tuberculatus*, Bosc	M
Hamites simplex (?), D'Orbigny	M

From the *same* block which yielded the example of *Douvilléiceras euomphalus* referred to above, Dr. Rowe and Mr. Sherborn obtained the following Cephalopoda, as well as one or two apparently undescribed forms :—

[1] A. de Grossouvre, "Les Ammonites de la Craie supérieure": Mém. Carte géol. détaillée de la France, 1893, p. 26.

[2] E. F. v. Schlotheim: Min. Tasch., vol. vii (1813), p. 111.

[3] F. Kossmat, "Untersuchungen über die südindische Kreideformation": Beitr. Pal. Geol. Österreichs-Ungarn, etc., Bd. ix, Hft. 3 and 4 (1895), p. 202, pl. xxiv [x], figs. 4*a–e*.

[4] M. Neumayr, "Über Kreideammoniten": Sitzb. d. k. Akad. d. Wissensch., Wien, Bd. lxxi, Abth. 1 (1875), p. 685.

Nautilus expansus, J. de C. Sowerby.
,, *Largilliertianus*, A. d'Orbigny.
Acanthoceras hippocastanum (J. de C. Sowerby).
,, ,, ,, , var. *compressa*, Jukes-Browne.
,, *Mantelli* (J. Sowerby).
,, *naviculare* (Mantell).
Schloenbachia Goupiliana (A. d'Orbigny).
,, *varians* (J. Sowerby).
Placenticeras Largilliertianum (A. d'Orbigny).
Scaphites æqualis, J. Sowerby.
,, ,, ,, var.
Baculites, sp.

IV.—Notes on certain Granitoid Fragments from the Culm Conglomerates, and Tourmalinized Grits from the New Red Conglomerates of South Devon.

By Arthur R. Hnut, Esq.

WHEN studying the Dartmoor Rocks some years ago I was anxious to ascertain whether any fragments referable to Dartmoor could be detected in the Culm conglomerates and Culm sandstones of South Devon. Sections cut from these rocks, collected for me by my friend Mr. W. A. E. Ussher, F.G.S., proved in every way so dissimilar from Dartmoor rocks and minerals that further investigation in that direction appeared useless. About the same time I collected a variety of fragments from the New Red breccia at Labrador, near Teignmouth, while Mr. Ussher supplied me from other localities. These, again, even when schorlaceous, differed so much from any rocks known to me that I postponed further inquiry in that direction also *sine die*. The facts seemed important, but the clue to their interpretation was wanting. During the past year Messrs. A. Somervail and Harford Lowe, Hon. Secretary and Hon. Treasurer of the Torquay Natural History Society, have been fortunate enough to obtain a number of specimens of a very fine-grained granitic rock among the pebbles of the Culm conglomerate in the neighbourhood of Roydon, South Devon.[1] These interesting rocks they have been good enough to submit to me for examination, with a view to ascertaining how they compare with the well-known types of the Dartmoor granites. Mr. Teall has also kindly lent me a slide cut from one of Mr. Somervail's specimens in his possession. I have seen altogether six slices of different specimens of the Culm conglomerate granites.

My knowledge of petrology does not warrant a technical description of the slides with identification of the felspars, so such will not be attempted. The six slides, though slightly differing, present a very strong family likeness and are all very fine in grain. One or other of them presents the following marked distinctions from any ordinary type of Dartmoor rocks known to me :—

(1) A tendency to a parallel arrangement of quartz and mica.
(2) Micro-porphyritic microcline and plagioclase, in a finer matrix.
(3) Felspars, occasionally bent.

[1] See A. Somervail, Geol. Mag., Dec. IV, Vol. V, p. 509.

(4) Strongly marked strain shadows in quartzes, more rarely seen in felspars.

(5) The fluid inclusions in quartzes very minute, with absence of chlorides.

(6) Absence of tourmaline.

Exception may perhaps be taken to No. 4, as strain shadows are strong in the veins of granite which intersect the Culm grits. But these are peculiar. The only case of equally strong strain shadows within the borders of Dartmoor known to me is shown in a slice from the neighbourhood of Brent Tor. But that locality may also be said to be peculiar. Taking texture alone, it would not be easy to find a Dartmoor granite as fine in grain as the fragments from the Culm conglomerate; and so far as my experience goes it would be extremely difficult to find a Dartmoor rock without either a trace of tourmaline as a mineral constituent or a trace of chlorides caught up by the quartzes.

I believe General McMahon, after considerable experience of Dartmoor, has observed that at the time of writing he had never seen a specimen without tourmaline. I may say that I have never yet examined a slide from Dartmoor which did not reveal traces of salts crystallized in the fluid inclusions, though in one or two cases these almost eluded detection. As a rule, wherever there is tourmaline in abundance in a Dartmoor crystalline rock there will also chlorides be found in abundance. Not so in the contact grits; there tourmaline seems to abound without the chlorides.

The differences between the Culm granite fragments and the Dartmoor rocks are sufficiently remarkable, but still more so is the fact that none of the innumerable varieties of Dartmoor rocks and minerals have been detected in the Culm conglomerates and sandstones. I have never seen a grain of felspar, mica, or quartz in the Culm rocks of which one could say, that it probably came from Dartmoor.

While engaged in examining the Culm granitic fragments I received in due course the Abstract Proceedings of the Geological Society for February, 1899, containing a notice of Mr. A. E. Salter's paper on Pebbles of Schorl Rock from the South-West of England, and Professor Bonney's observation that Mr. Salter's pebbles resembled certain tourmalinized sedimentary rocks which occurred in the South-West of England and in the Budleigh Salterton conglomerate. This paper, coming when it did in the nick of time, interested me greatly, and Mr. Salter was kind enough to send me a few scraps of his pebbles. In one of them, to my great surprise, I recognized my anomalous schorlaceous rock from the Labrador breccia. Mr. Salter then favoured me with a sight of his slides. They seemed to me to show that one great Devonshire problem had been solved, viz., the origin of some of the doubtful fragments of the New Red breccias.

By diagnosing Mr. Salter's pebbles, Professor Bonney had cleared up a difficulty I had despaired of ever seeing explained. Of course, it is easy to be wise after the event, so it was no surprise to find

I had in my own collection of slides the whole chain of evidence from beginning to end.

My own series consists of one contact slide, granite-and-grit, from near Bovey Tracey, one granite-and-grit from near Lustleigh, three fragments from New Red of Labrador, two near Ideford, two near Yeoford, and two, strangely enough, from the Brixham raised beach. They are all members of one remarkable family.

Comparing my own slides in the light of Mr. Salter's, I noticed that both my contact slides had in their granite portions well-marked crystals of idiomorphic brown tourmaline. On close examination minute crystals of the same brown tourmaline could be seen pervading the interstices between the quartz granules of the Culm-grit portions of the slides. A similar invasion by tourmaline was then noticed, both in Mr. Salter's pebbles and in my specimens from the New Red conglomerates. In some cases the aluminous cement of the quartz granules seemed transformed into tourmaline. The tourmaline in the conglomerate fragments is chiefly a bluish-green variety, whereas that in my contact slides is brown.

Of Mr. Salter's specimens I cannot, of course, speak, nor have I retained a single note of them. I cannot refrain from saying as much as I have, as never before in my experience has the comparison of notes thrown so much light into an absolutely dark corner.

It is abundantly evident that all these tourmalinized grits are the débris of the rocks once immediately covering the great granitic areas of the West of England. Grits once plutonic, permeated at high pressure by the mineralized waters which filled the fissures in the granite with the well-known felspar-quartz-schorl veins. Such action on a grit results in a very deceptive altered rock, which may be anything between a sedimentary rock and a crystalline one, but all with the common link of tourmaline running through them, and tourmaline very unlike the types usually occurring in the granitoid rocks, where crystallization has not been so much hampered by the original minerals of the sedimentary rock; while, in the veins, crystallization has been quite unimpeded.

In the case of a tourmaline vein, it is often easy to see that the mineral is as original as the quartz accompanying it. A fissure existed, and freshly crystallized minerals occupied the space. But in the case of mineralized waters attacking the aluminous or felspathic matrix of a grit, it is not easy to distinguish to what extent the newly-formed tourmaline is derived from the pre-existing felspathic element, or from the invading fluids, which, perhaps, in a neighbouring vein prove themselves quite capable of forming felspar quartz and tourmaline without any outside assistance; whereas the felspar alone could supply neither boron nor fluorine. Tourmaline is truly a protean mineral occurring in various forms, each form no doubt arising from its own peculiar originating cause.

The non-schorlaceous granites of the Culm conglomerates, coupled with the schorlaceous grits of the New Red conglomerates, suggest quite a number of interesting problems. The Culm conglomerates bear witness that no portion of the Dartmoor granite, or of its

immediately covering grits, was at that time undergoing denudation. The Labrador volcanic breccias, as they have been called, bear witness to the fact that during their accumulation the covering grits were being largely demolished, the granite sparingly, if at all. Now, assuming these breccias to be Permian, would it not be possible to trace the gradual uncovering of the Western granites by the character of the débris found throughout the newer beds of the Red Sandstones? A very arduous task, no doubt, but an interesting one. Then the schorlaceous rocks of such distant localities as Teignmouth, Budleigh Salterton, and the Midlands, should be carefully compared. Perhaps the first question to get answered is—Is there any region known, except the West of England, which produces crystalline schorlaceous rocks crammed with chlorides; and fine grits, saturated, so to speak, with tourmaline?

I need not say what a very important bearing these tourmalinized grits have on the volcanic theory of Dartmoor. Were the Dartmoor rocks first exposed to denudation, the once plutonic tourmalinized grits; or were they the higher lavas and ashes of a volcano? They cannot very well have been both. Then how are we to reconcile the apparently early appearance of these covering grits in the conglomerates with the famous Cattledown hypersthene-andesites found by the late Mr. R. N. Worth, and referred by him to an ancient Dartmoor volcano? Dartmoor is a wondrous easy problem if we suppress inconvenient evidence. But hear all sides, and it is a tough nut to crack.

In conclusion, I cannot refrain from expressing my admiration of the pertinacity with which my friends, Messrs. Somervail and Lowe, have so continuously attacked the Culm conglomerates. These granitic fragments are entirely new facts, and facts which may lead to a good many more, and one real new fact about Dartmoor is worth a volume of theories, however large such volume may be.

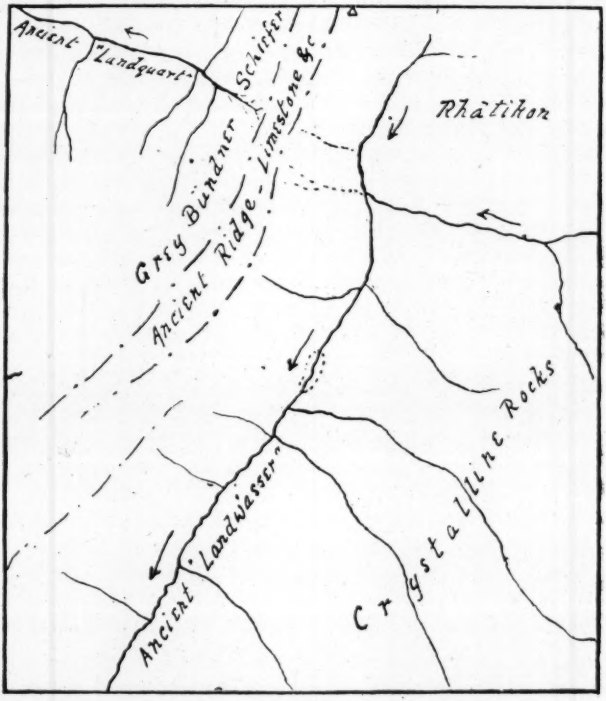
V.—On the Courses of the Landwasser and the Landquart.

By A. Vaughan Jennings, F.L.S., F.G.S.

CASES of relatively recent change in the courses of rivers, due to the invasion of their valleys by neighbouring and more rapidly working streams and the consequent diversion of their waters, have been investigated of late years by an increasing number of geologists in different countries. Such phenomena are, of course, most frequent in mountain districts, and the Swiss Alps have yielded many examples of greater or less certainty. Some cases are evident and undeniable; others are difficult to decide upon, and need careful consideration of all available evidence; while in yet other instances it is possible that statements as to the occurrence of such changes have been accepted on inadequate authority. The generally received opinion as to the present and past relationship of the Landwasser and the Landquart can certainly not be included in the last category, but neither can it, I think, be rightly placed in the first.

The Landquart is a river of Northern Graubunden which now flows from the glaciers of the Silvretta group northward and

westward through the fertile Prätigau to join the Rhine between Chur and Ragaz. Near the village of Klosters, where the narrower valley of its mountain course widens into the ampler trough of the Prätigau, it receives two tributaries. From the north flows into it the Schlappina, rising behind the rugged mass of the Eastern Rhätikon; on the south opens a side valley, which, when followed up, is found to lead to the saddle that now closes the northern end of the famous 'valley' of Davos. The stream which apparently

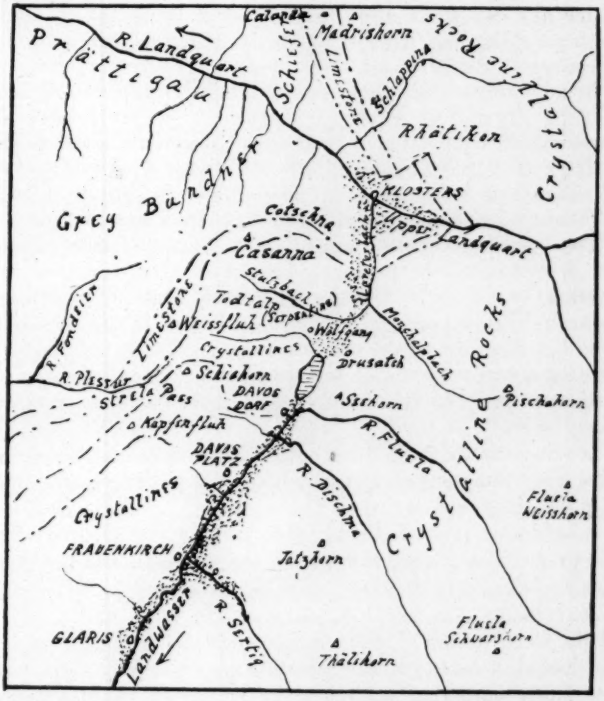


I. Former drainage of the Davos district according to Prof. Heim.

descends from this saddle proves to be formed by the union of two, one from the east and one from the west,[1] but there is none flowing directly from the broad pine-clad divide between Wolfgang and the Drusatch Alp. On the south side of this curious 'Kulm' lies the deep Davoser See, and into the long, almost level alluvial area which succeeds it flow three rivers—the Fluela, the Dischma, and the Sertig. The Fluela and the Dischma enter near together below the south end of the lake, and form, with the insignificant outflow

[1] The streams are the Mönchalpbach and the Stützbach; the result of their confluence I have called the Lareterbach, but find that on some maps it is called the Stützbach down to Klosters.

of the lake, the origin of the Landwasser. Five miles below the lake, but only at a level of thirty metres below its surface, the Landwasser is joined by the Sertig, which flows also northward and westward from its source among the snows of the Ducan. Thus reinforced the Landwasser flows on past Frauenkirch and Glaris, and through the Züge gorge, finally joining the Albula, and so in time also reaching the Rhine.



II. Present drainage of the Davos district.

Scale 1:250,000

Professor Heim considers that this distribution of the two rivers and their tributaries does not represent the original drainage conditions of the area. He is of opinion that the valley of the Landwasser once extended northward above the present site of Klosters, and that its river was continuous with that rising at the head of the Schlappinathal.[1] The western side of this valley consisted of a rock-wall continuous with the masses now remaining on either side of the Prätigau—the Mädrishorn and Calanda on the north and the Casanna and Cotschna on the south. This wall, on the hypothesis in question, was cut through by the head waters of

[1] "Mechanismus der Gebirgsbildung," p. 321.

the river which then occupied the Prätigau, and was eroding its source more rapidly than the ancient Landwasser could deepen its bed. The result was that the latter was cut into by the former, and its waters, with those of its upper tributaries, diverted into the channel of the pirate stream.

This theory has, I believe, been accepted by geologists in general both in Switzerland and elsewhere. It has been incorporated by Professor Tarnuzzer in his revised edition of Theobald's "Naturbilder aus der Rhätischen Alpen," and it has been made widely known to English readers by its inclusion in Sir John Lubbock's "Scenery of Switzerland."[1]

It may seem rash to question a view put forward by so high an authority and so strongly supported; but as I have already to some extent committed myself to an opinion on the subject,[2] it is perhaps both justifiable and advisable that I should point out the considerations which, during several months' study of the district, have seemed to me to weigh against its too ready acceptation.

The conditions which, according to the hypothesis, existed before the diversion of the ancient 'Landwasser' are shown in Fig. 1. Even at first sight there seems here something different from the usual type of river origin. There is an absence of the tree-like structure, of the oblique convergence of tributaries that one associates with the upper waters of a drainage system, while the northward trend of the main feeders from the east seems distinctly exceptional.

Leaving these difficulties aside, however, for the present, and observing the sources from which the river would have been supplied, it is evident that the ancient 'Landwasser' must have possessed a current of considerable volume and great erosive power. The present Landwasser, fed from the mountains of the Scaletta and Ducan districts, is no mean excavating agent in the Frauenkirch-Filisur valley, but its predecessor would have had in addition the whole force of the 'Upper Landquart,' the drainage of the snow and icefields of the great Silvretta group. We may therefore be reasonably sure that such a river would be rapidly deepening its channel and tending to add to the relative height of its western wall.

The question then arises as to the nature of the stream on the other side of this barrier, and whether it is likely to have had the erosive force requisite even to keep pace with its powerful neighbour. It is difficult to imagine that such can have been the case. The lower Landquart is supplied by numerous streams from the side valleys of the Prätigau, but these enter it approximately at right angles from north or south, and their representatives at that time could have taken no part in the denudation of the transverse cliff-like outcrops at the head of the system. When the rock ridge stretched across from the Mädrishorn to the Casanna the head waters of the Landquart would have been only the little rivulets rising on the western face of the ridge of itself. The Landquart between Klosters and Serneus owes its existence, according to the theory

[1] London, 1898, p. 190. [2] Quart. Journ. Geol. Soc., vol. liv; August, 1898.

itself, to the removal of the barrier ridge, and cannot therefore be regarded as the cause of that removal. There were doubtless small streams at work on the east side of the ridge (as suggested by the dotted lines in Fig. 1), but it is difficult to understand how there could have been any river describable as the former 'Landquart' engaged in its destruction.

The conditions which then existed may be paralleled at the present day by the source of the Plessur, a short distance to the south. This river is an important one in the Schanfigg valley after the lateral influx of the Fondeier and the Arosa-wasser: its upper waters are insignificant, and originate in a rivulet between the Weissfluh and the Schiahorn. The limestone ridge of the Schiahorn and Kupfenfluh here occupies just the same position in relation to the Davos and Plessur valleys that the ancient ridge at Klosters did to the Landwasser and Prätigau. Between the two mountains the ridge is lowered where it is traversed by the Strela Pass, but there is practically no running water at work on the western face at this point, and no evidence of denudation except that of atmospheric agents and the cutting of the Schiabach on the east. Sir John Lubbock,[1] it is true, suggests that "It is possible that in the distant future the Landwasser may be still further robbed of its territory. The waters of the Davos Lake, the Fluela, the Dischma, and the Kuhalpthal now take a very circuitous route to Chur, and it is not impossible that they may be captured and carried off by the Plessur."

Such a change may appear conceivable when considered only with the aid of sketch-maps, but I venture to think that anyone who carefully observes the contours or studies the locality in person, will find it very difficult to imagine its possibility. At its lowest the limestone ridge is 2,000 feet above the Landwasser at Davos, and, as pointed out above, is suffering no specially rapid denudation. On the other hand, the Landwasser is a considerable current which under normal conditions would be constantly lowering its level and so relatively adding to the height of the divide between it and the Plessur basin. It seems to me that a similar condition of things would have existed in the Klosters neighbourhood according to Professor Heim's theory.

It may be argued that some geological peculiarity of the district may have contributed to a rapid destruction of the ridge. It is true that the neighbourhood is one of complex structure — of the rapid thinning of some strata, and of folds and faults, torsion and overthrust. The hypothetical ancient 'Landwasser,' however, seems to have followed its own course independent of the disturbed strike of the strata and uninfluenced by the variety of rocks through which it cut, and we have no reason for supposing any special conditions that would have assisted its rival. Had there been any important line of weakness running east and west, the north-and-south course of the Landwasser would scarcely have been in the first instance established.

[1] "Scenery of Switzerland," p. 192.

Again, a study of the geological map may suggest that the rapid back-cutting of the Landquart was due to the more rapid erosion of the grey Bündner Schiefer of the Prätigau, in comparison with that of the crystalline rocks, limestones, etc., which formed the bed of the 'Landwasser.' The grey Bündner Schiefer, however, lay only at the base of the ridge, and it is the through-cutting of the ridge itself that is the difficulty. It was only after the cutting of the ridge that the Landquart would in the critical area have arrived at the underlying shales, and this brings us to a consideration of the nature of the ridge itself.

Although the district is a difficult one, owing to its being the point at which the simple outcrop-line of stratified works running south-east to Klosters from the Scesaplana district passes into the complex folds traceable near Davos, yet a study of the present outcrops of the various formations gives us a fairly accurate idea of what must have been the structure. Its most conspicuous feature was doubtless the band of 'Hauptdolomit' now seen to form the Casanna on the south of the Prätigau and the Calanda on the north. A line drawn from the present top of the former, doubtless then considerably higher, to the upper limit of limestone on the latter gives a height above the sea of 2,650 metres. This would be about 4,800 feet above the present level of Klosters, and 2,800 feet above the Drusatch Alp. The limestone series was accompanied by a greater or less thickness of Verrucano and Casanna Schiefer, with probably a band of serpentine; and the whole series was thrust over the grey Bündner Schiefer, which dipped south and east below it. Above the limestone and its associated rocks there was in all probability a capping of the schists and gneisses belonging to the older crystalline series, such as now overlie it to a vast thickness on the Eastern Rhätikon, and still remain to form the peak of the Mädrishorn. What may have been the thickness of this crystalline covering it is impossible to say. Even, however, if we suppose it to have been removed before the period under consideration there would still remain a barrier of a height and constitution to render it a formidable task for a few rivulets to attempt in competition with the forceful river on its further side.

Lastly, when one considers that the ancient 'Landwasser' represented not only the combined Schlappina, Upper Landquart, and Landwasser of to-day, but almost certainly a far greater volume of water owing to the wider extent of the snow and ice-fields on the eastern mountains—a difference of conditions that would not have had proportionate effect on the Calanda-Cotschna ridge — the inequality between the two agencies at work becomes still more conspicuously marked.

Such are some of the difficulties which, it seems to me, one must overcome before accepting Professor Heim's view. When we endeavour to get an idea of the bed of the ancient 'Landwasser,' and attempt to derive from it the present conditions between Klosters and the Davos-Glaris region, we meet with considerations no less

difficult to reconcile. To appreciate these it is necessary to observe some of the peculiarities of the Davos 'valley.'

If we follow up the Lareterbach from Klosters we find it descends in a steep valley with solid rock on the east and a great accumulation of moraine and detrital material on the west. Some three miles up, near Laret, it curves west, and is seen to descend from the pass between the Casanna and the Todtalp. Just below this bend it receives the Mönchalpbach, flowing from the Pischa glacier on the east, but there is no stream descending in the middle line of the valley. Half a mile south of the Stützbach is Wolfgang, the 'Kulm' of the Davos 'valley,' 1,634 metres above the sea, or 425 above Klosters. West of Wolfgang is the serpentine mass of the Todtalp, lying back at some distance but with a great talus-fan at its foot, which spreads over the Kulm and has apparently forced southward the stream of the Todtalpbach. East of Wolfgang lies the remarkable rounded and tree-covered elevation which stretches transversely across the valley and reaches a height of 1,776 metres at the Drusatch Alp, where it abuts against the schists and gneisses of the Hörnli.

The southern slopes of this ridge descend to the Davoser See, which is a mile in length and about half as much in width. While popular tradition as to the depth of the lake is undoubtedly exaggerated, the evidence of sounding and of calculation from the slopes of the surrounding mountains, leaves no doubt that the bottom is some 150 metres below the surface at the deepest point, about a third of the length from the north end. The south end shallows rapidly and terminates in the low-lying meadows around Dorf, which in turn are continued into the alluvial flat stretching on past Davos Platz. Into these meadows flows the Fluela, and its now canalized course, turning southward and receiving the little stream issuing from the lake, forms the origin of the Landwasser of to-day. Increased in volume by the influx of the Dischma, the Landwasser flows on, with but little drop, to Frauenkirch. Here it lies on the western side of the valley, and on the east a vast accumulation of detrital material marks the mouth of the incurrent Sertig. This mass presents a steep bank 30 metres high to the river, and is cut out above into the wide flat terraces of the Wildboden and Junkersboden. The level of these terraces is just the same as the present level of the lake, so that the height of their terminal bank represents the total fall of the Landwasser in the first five miles of its course. Below Frauenkirch the river, no longer canalized, pursues a winding course past Spinabad, Glaris, and Monstein, and then plunges into the gorge of the Züge. As far as Glaris it is flanked on the west by great masses of detrital material, but soon after passing that village it flows practically on its true rock bed.

In a paper published last year [1] I called attention in greater detail to these general features of the Davos area, and also pointed out—

[1] Vaughan Jennings, "On the Structure of the Davos Valley": Quart. Journ. Geol. Soc., vol. liv (1898).

(1) That the Landwasser was not running as at present when the detrital fan opposite Frauenkirch accumulated, since a portion of that fan still exists on the west side of the valley, separated from the main mass by a subsequent down-cutting.

(2) That as the whole bed of the Upper Landwasser lies on alluvial and detrital material its present course gives no indication of the real contour of the rock-floor; and the latter may, and probably does, slope northward.

(3) That a comparison of the slopes of the mountain sides at a series of points along the Davos area also gives support to this suggestion.

(4) That the ice-movement in the district was certainly northward.

(5) That solid rock *in sitû* cannot be found on the Wolfgang-Drusatch ridge, and that this feature in the landscape probably consists entirely of moraine material, mainly ice-borne from the Todtalp.

The conclusions which I based on these observations were as follows:—(1) That in Pre-Glacial times the Fluela, the Dischma, and perhaps the Sertig, flowed northward into the Landquart. (2) That in Post-Glacial times the presence of the Wolfgang-Drusatch mass and the detrital accumulation round Clavadel and Frauenkirch—then, as I have shown, far greater than now—caused the formation of a lake between these two points, probably with an outflow over Wolfgang. (3) That in time the work of the Landwasser below Frauenkirch, and perhaps of the Sertig also, so weakened the southern dam as to cause an outflow of the lake in that direction, carrying with it the waters of the Fluela and Dischma.

In making these suggestions I did not fully realize the extent to which they were connected with the whole question of the past history of the rivers; nor did it occur to me that some geologists would be willing to accept the idea of the former northward flow of the eastern tributaries, while still holding not only to Professor Heim's view but also to a belief in a solid rock ridge between Wolfgang and Drusatcha. I may, therefore, perhaps be allowed to say something in support of the conclusions I then arrived at before pointing out their bearing on the main question under consideration.

It has been objected by some that the detrital accumulations opposite Frauenkirch are mainly of a fluviatile character, and as a whole are not of sufficiently compact and massive character to have held up the waters of a great lake. We have exposed here, however, only what is probably a fringe of lighter material round the edges of a mass of coarser detritus. There are abundant examples near Clavadel of large rock-fragments ice-borne down the Sertig valley. It is also by no means necessary to suppose that the southern dam was merely a transverse barrier at this point. It is very probable that the whole valley was choked with débris as far south as Monstein. The enormous thickness of detritus full of ice-borne blocks which occurs at that village doubtless once crossed the Landwasser valley and abutted against the western cliffs of the Züge. In the same way the banks and terraces of the Langmatter

district are cut out of a mass that probably once stretched across the valley, and was heaped up against the slopes of the Rinnerhorn. We have here an amply sufficient amount of material to have supported the lake. The *fact* of the former southerly extension of the lake is generally accepted and perhaps undeniable,[1] but there seems no other way of accounting for its existence than that here suggested.

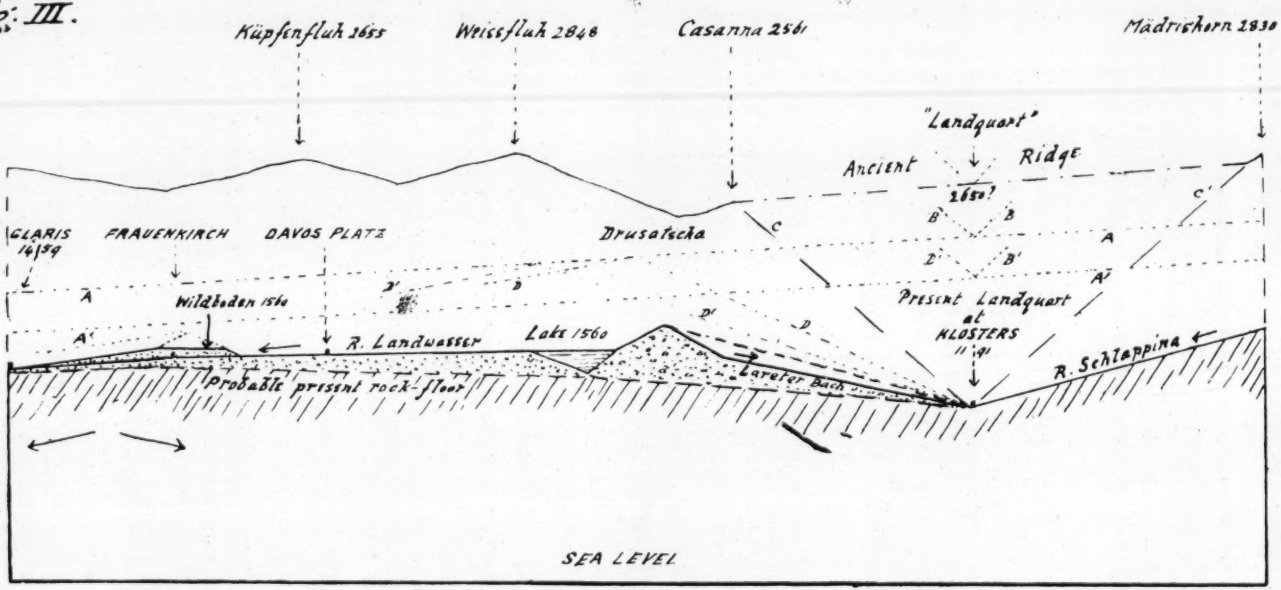
Secondly, as to the nature of the Wolfgang-Drusatch barrier. When I made the suggestion above referred to I based my conclusions on physiographic grounds only. The form and position of the mass and its overgrown character, offering a striking contrast to the bare and weathered Todtalp of which it has been regarded as an extension, suggest anything but an ancient ridge of rock exposed to denudation since Pre-Glacial times. It is evident that an immense amount of material must have been removed from the east of the Todtalp; yet we do not find great accumulations of serpentine in the lower valleys. Evidence of extensive glaciation is, as Theobald specially noticed, abundant on the upper Todtalp slopes. What, then, is more natural than to suppose that the removed material was piled up in this position? Added to this, the difficulty of in any other way accounting for the lake and other features of the valley seemed to me conclusive.

Since then I have spent some months in studying the solid geology of the neighbourhood[2] and find that the results of this totally different line of inquiry are confirmatory of my former opinion. Thus the serpentine band undoubtedly occupies a constant position between certain rocks: it follows, that is, the strike of all the other formations. Its outcrop runs from between the Schiahorn and the Weissfluh down the Meierhoferthäli, and obliquely across by Wolfgang to Laret; it reappears on the east of the Lareterthal at Rüti, and crosses the Upper Landquart valley to Monbiel. The line of strike thus *excludes the whole of the Wolfgang-Drusatch barrier.* If that mass were composed of rock *in sitû* it would not be of serpentine, but of crystalline schists, limestone, and 'verrucano'; a continuation of the rocks of the Dörfliberg and

[1] I have been several times asked what date may be attributed to the former extension of the lake towards Frauenkirch, but I am not aware of any evidence on which conclusions can be based. The infilling of the old lake by detritus from the mountain sides and material brought down by the streams must have been going on since its earliest days, but it is probable that the final disappearance of standing water from parts of the Davos level is a very recent matter. The peat at the southern end seems modern, and above the Davos-Frauenkirch road the talus slopes contain a considerable quantity of peaty material near the surface. At the northern end, I am told that the Fluela discharged into the lake within the memory of those still living. It is said also that the Romans used the Fluela Pass as a route between the Prätigau and the Engadine, and the finding of Roman remains at Drusatcha suggests that they traversed the ridge at that point and passed round the shoulder of the Seehorn. This is not likely to have been their route if they could have crossed in the neighbourhood of Dorf. The name Wolfgang itself is said to represent the fact that the ridge formed the path of wolves from the eastern mountains, and this also seems to suggest that the foot of the Fluela valley was recently closed by the waters of the lake.

[2] The results of this survey are embodied in a paper read before the Geological Society on May 10th, 1899.

Fig. III.



A,A'— Hypothetical course of the ancient Landwasser.

B,B'— Stages in the cutting of the ancient ridge by the "Landquart"

C,C'— Present valley in position of the ancient ridge (Prättigau)

D,D'— Hypothetical stages in the production of present conditions between Klosters and Glaris.

SCALE 1:125,000. VERTICAL x2

HEIGHTS IN METRES

of those which are seen on the east bank of the lake and which reappear north of the Mönchalpthal.

Returning now to the question of the course of the ancient Landwasser, I have endeavoured in Fig. 3 to represent in diagram its possible changes of position in relation to the Davos area.

If we imagine the Schlappinathal brought into line with the Laret-Landwasser valley, we obtain the present surface contour here shown. If we take a point near the source of the Schlappina and draw a line to the point near Glaris where the Landwasser now flows on solid rock, we may get an idea of what might have been the river-bed had the ancient Landwasser persisted to the present day. The lines A and A^1 drawn parallel to this at different heights may therefore represent its course at different remote periods. The cutting away of the western ridge may be represented by a succession of notches, B, B^1. On the supposition that this cutting was more rapid than the lowering of the river-bed there would have come a time when one of the notches reached the line A, A^1, and the Landwasser was consequently diverted into the Prätigau.

Subsequently the new river, the Landquart, widened its valley, till this gradually approximated to its present size, represented diagrammatically by C, C^1. At the same time the Schlappina on the north would be progressively lowering its level and nearing its present position. On the south it may be supposed that the stream representing the present Lareterbach would have lowered its bed through a succession of stages represented by D and D^1. The result of this would be the production of a watershed between it and the basin of the remaining Landwasser; there would be a ridge or divide just where, as a matter of fact, there is a deep lake. If the Wolfgang-Drusatch ridge were of solid rock *in sitú* it might at first sight be thought to satisfy the required conditions, but it is evident that its sudden drop of 350 metres on the south could not be attributed to erosion by the Landwasser. This brings us to the most important point of all: the striking fact that the bottom of the lake is *actually lower than the bed of the Landwasser at Glaris.*

It seems so impossible to reconcile this fact with any view but that which supposes a northerly slope of the rock-floor of the valley, that it appears scarcely necessary to pursue the subject further, and we may summarize the results of our whole inquiry somewhat as follows:—

(1) The theory of the former origin of the Landwasser in the Schlappinathal is not tenable if the Wolfgang-Drusatch ridge is solid.

(2) If this ridge is an accumulation of Glacial age the hypothesis may be still tenable, but only on the supposition that after the diversion of the Landwasser, the Fluela and Dischma were also turned northward and produced a rock-bed sloping toward Klosters from some watershed south of Davos.

(3) This second possibility does not, however, dispose of any of the difficulties attending the cutting of the Casanna-Mädrishorn

ridge, and under these circumstances it seems natural to suggest that after all the Fluela, Dischma, and Sertig, as well as the Schlappina, may have been original tributaries of the Landquart.

In this case there is no longer any difficulty in understanding the cutting of the mountain barrier just mentioned. The old river system would have had a much more usual character and would naturally take its place among similar systems in the surrounding mountains.[1] And lastly, if we accept this view, we are no longer at a loss to explain the anomalous physiographic features of the Davos valley, but, on the other hand, are in a position to offer a simple solution of its problems.

REVIEWS.

I.—Remarks on the Heliolitidæ. By G. Lindström. Kong. Svenska Vetenskaps-Akad. Handlingar, Bd. xxxii, No. 1. 4to; 140 pp., 12 plates. (Stockholm, 1899.)

UNDER the above modest title Professor Lindström has brought out a very important work dealing with the Heliolitidæ, a well-known family of Palæozoic Corals. At first intended as a review of the Swedish species merely, the scope of the work was afterwards enlarged, so that it now comprises a critical description of nearly all the known forms of this family, and it may be considered as a monograph of the group. The value of this work to the palæontologist depends not so much on the descriptions given of new and rare forms as on the very thorough and complete manner in which the author has investigated the structure of known species, by means of microscopic sections, and by this means establishing the detailed features by which one species may be distinguished from another. The characters assigned to the earlier known forms of this group were very frequently limited to those shown on the surface merely, and as these are in many instances very similar in species having a different internal structure, much confusion has consequently resulted. The author has spared no pains to ascertain the microscopic structural characters of the types of the known species, and these are represented with marvellous fidelity in the magnificent series of plates accompanying the memoir, and thereby much of the uncertainty respecting these species will be removed.

The earliest horizon on which the Heliolitidæ make their appearance is nearly at the summit of the Lower Silurian (Ordovician), none having been found below the Bala beds in England or the Wesenburg beds of Estland, whilst their highest limit is the lowest beds of the Upper Devonian. They have a very wide geographical distribution, as they are found in most countries

[1] Thus, the direction of the Fluela, Dischma, and Sertig is exactly the same as that of the eastern tributaries of the Inn, such as the Bernina and Chamuera. Again, their relationship to the present Lareterbach and the Landquart may be exactly paralleled north of the Rhätikon by the conditions existing between the Valzavenz and Vergalda, the Gargellenthal and the Montafun.

where there are outcrops of Silurian and Devonian rocks. They are more especially abundant in Northern regions both of Europe and America, and the most prolific locality is the Isle of Gotland, from which place Lindström enumerates thirty species and varieties, out of a total of forty-six described in this memoir. Only eleven species occur in British rocks, and six or seven forms have been recognized in Australia.

According to the author, there is very great difficulty in defining the limits of species in the Heliolitidæ, since even in the corallites of the same compound stock there is a considerable amount of variation in their dimensions, their distance from each other, and the amount of the cœnenchyma between them, but he finds that the shape and size of the septa, the nature of the cœnenchyma and dissepiments, and, subordinately, the mode of growth, are of more systematic value.

Lindström considers that the cœnenchyma is the most prominent general feature in the Heliolitidæ, and in this and the allied family of the Coccoseridæ four kinds of it are distinguished: (1) tubular, consisting of narrow polygonal tubes divided by regular horizontal tabulæ, as in *Heliolites*; (2) vesicular, of thin convex lamellæ, as in *Propora*, E. & H.; (3) bacular, of solid vertical rods or *baculi*, as shown in the Coccoseridæ; and (4) compact, composed of a dense, somewhat granular, homogeneous mass, showing longitudinal lines, the traces of filled-up tubuli. This occurs in *Pycnolithus*, gen. nov.

Considerable discussion has taken place with respect to the nature of the cœnenchyma in *Heliolites* and its allied genera, and the author gives an account of its early stages and manner of development. It is seen growing on the lower edge of the calicle of a primary or initial cornet-shaped polypierite, not more than 0·6 mm. in length and width, and may be developed either from one side of this initial form or all around a calicle, which, by rising as a tube above the parent cœnenchyma, introduces the intracalicinar gemmation, and thus for a time exists as a portion of a solitary individual. Lindström supports the view that the cœnenchyma of the Heliolitidæ is an endothecal structure, although no exterior theca for every single polypierite in a compound coral is developed, and, strictly considered, that it forms an integral part of every calicle in the compound coral.

Nicholson and Moseley, on the other hand, regarded the corallum in *Heliolites* as tenanted by two kinds of polypes: one kind, fully developed, inhabiting the septal calices (autopores); and the other, rudimentary form, occupying the surrounding tabulated tubes (siphonopores), which, therefore, were not cœnenchymal in character. It must be acknowledged that there are some facts tending to support the view, still held by some recent writers, that the siphonopores (cœnenchymal tubes) in *Heliolites* were occupied by zooids. Thus, for example, Nicholson[1] records the fact that in *Heliolites dubius*, Fr. Schmidt, a single siphonopore may sometimes be observed to be

[1] Man. Pal., vol. i (1889), p. 337.

developed vertically and directly into an autopore. This observation has been confirmed by Gardeson, and Lindström also states that the narrow tubuli of the cœnenchyma in this species by-and-bye expand or widen and are changed into real calicles (p. 71). A similar metamorphosis of a cœnenchymal tube into a true calicle by a gradual increase in width and the development of septal spines, likewise occurs in *Heliolites hirsutus*, Linds., sp. nov.

With regard to those genera in which the cœnenchyma is without tubuli, and consists of vesicular tissue with solid spines or rods, or of a compact sclerenchyma, the question of dimorphism can hardly arise.

In favourably preserved specimens, the structure of the thecal walls and the septa in the Heliolitidæ can be seen to consist of minute microscopic fibres radiating upwards and inwards from a median dark line (whitish by reflected light), the same as in most other corals. The septa in *Heliolites* are thin laminæ, sometimes with spiny margins; in the Plasmoporinæ they are reduced to a series of spines which spring from narrow longitudinal ridges within the calicle. Their degree of development varies much in the same stock, and in some instances they appear to be altogether wanting. There are twelve septa in the normal calicle, and this number is very constant throughout the group. There can be no doubt of the true nature of the septa in the Heliolitidæ, and they are entirely distinct in character from the pseudosepta in *Heliopora*, with which they have wrongly been compared. Three modes of increase have been observed: by cœnenchymal, intracalicinal, and epithecal or cœnothecal gemmation. As a general feature, Lindström has noticed that some of the earlier species are characterized by closely placed calicles and slight development of cœnenchyma, which may perhaps indicate a descent from ancestors without cœnenchyma. In Lower Silurian (Ordovician) strata the predominant types belong to the Plasmoporinæ and the allied Coccoseridæ (these latter are confined mainly to the lower horizon); whilst the Heliolitinæ proper flourished principally in the Upper Silurian.

As the chief distinguishing features of the Heliolitidæ and the allied Coccoseridæ, the author states that the individual polypierites are composed of an interior area enclosed within an inner theca, with twelve regular septa, and of an exterior area without any separating wall for each polypierite, and forming a differently shaped cœnenchyma.

Lindström subdivides the Heliolitidæ into three tribes, mainly according to the nature of the cœnenchyma: (1) Heliolitinidæ, with lamellar septa and cœnenchyma of polygonal tubes; (2) Plasmoporinæ, theca thick, cœnenchyma vesicular; and (3) Pycnolithinæ, with dense, compact, granular cœnenchyma.

The subfamily Coccoseridæ is characterized by short thick septa, the central area of the calicle is filled with columnar bacilli which project as papillæ on its floor, the cœnenchyma is bacular, tubes when present are narrow with a few tabulæ. In this sub-group the following three genera are included: *Coccoseris*, Eichwald, *Protaræa*, E. & H., and *Acantholithus*, Linds., gen. nov.

In the tribe Heliolitinæ are comprised three genera: *Heliolites*, Dana, with a cœnenchyma of tubes of one kind and size; *Cosmiolithus*, gen. nov., in which two different kinds are present; and *Proheliolites*, Kiær, with slightly developed cœnenchyma, with gemmation from single tubes. The septal spines are bent downwards.

The predominant genus, not only of the tribe, but of the whole family, is *Heliolites*, Dana, and in this genus eleven species and varieties are described, six of these being new forms. The very thorough microscopic revision to which the various species of the genus have been subjected by the author has involved, as might have been anticipated, the suppression of some reputed species and the transposition of others, and it may be that some of these changes will not be accepted without protest. As an instance of a needful alteration may be mentioned *Heliolites* (*Fistulipora*) *decipiens*, McCoy, sp., hitherto regarded, even by Lindström, as a species, but now proved to be only a phase or growth modification of *H. interstinctus*, L., and thus merely a variety of this latter. In the same specimen there may be found some calicles with fully developed septa as in *H. interstinctus*, others without a trace of septa, as in *H. decipiens*, and yet other calicles with the septa unequally developed.

As incidental to the presumed affinity between the Heliolitidæ and such forms as *Monticulipora*, *Callopora*, and *Fistulipora*, now very generally regarded as Polyzoa, the author enumerates seven chief differences in the structure of these groups, of which the most important appears to be the dissimilarity of the intimate microscopical structures composing their walls.

In the tribe Plasmoporinæ are included *Plasmopora*, M. Edw. and Haime, *Propora*, M. E. & H., *Camptolithus*, gen. nov., distinguished by having the same kind of vesicular tissue in the calicles as in the cœnenchyma; and *Diploëpora*, Quenstedt, in which there are two kinds of cœnenchyma—an inner of vesicular character and an outer of closely arranged parallel rods. The only species of this genus is *D. Grayi*, M. E. & H., sp. The genus *Lyellia*, M. E. & H., is not retained, on the ground of its similarity to *Propora*.

As a special feature of *Plasmopora*, it is pointed out that the septa extend beyond the calicular theca, and their ends are united together by a curved lamina so as to form a stelliform area or aureola, enclosing longitudinal compartments around the calicle. Thirteen species are placed in the genus, ten of which are new forms. In *Propora* the calicles are exsert, the cœnenchyma entirely vesicular, and there is no aureola. Nine species and varieties, including six new forms, are described. The genus *Pinacopora*, Nichol. & Eth., is considered to be a synonym of *Propora*.

The only genus of the Pycnolithinæ tribe is *Pycnolithus*, gen. nov., in which the common type of calicle is accompanied by a dense, compact cœnenchyma, without any structure, but with a surface ornamented by shallow elongate grooves and pits.

We are unwilling to conclude this notice without again repeating our warm appreciation of the able manner in which the subject has been treated by Professor Lindström, and our admiration of the

results of his long-continued efforts in investigating the minute characters of Palæozoic corals. The present memoir is a worthy addition to the numerous valuable contributions to palæontology which the author has made during his long career. Palæontologists of all countries will cordially echo the author's thanks to the Royal Swedish Academy of Sciences for defraying the expenses of publishing such an important work, and more particularly the English-speaking ones for its appearance in this language. But we have often felt in turning over the pages, what a great pity it was that the proofs had not been revised by some one whose knowledge of the mother tongue would have eliminated those subtle mistakes inevitable to those "not to the manner born." G. J. H.

II.—The Geology of the Country around Carlisle. By T. V. Holmes, F.G.S. 8vo; pp. iv, 64. (London: printed for H.M. Stationery Office, 1899. Price 1*s.* 3*d.*)

A GOOD many years have elapsed since Mr. Holmes was engaged on the Geological Survey of the country around Carlisle, and there has been a regrettable delay in issuing the present Memoir. This has to some extent arisen (as the Director-General points out) from the difficulty in interpreting the structure and relations of the Permian and Triassic rocks of the district. The country in question is almost wholly covered with Drift, and it was therefore by no means easy to piece together the evidence obtained from a few boreholes and from the cliffs bordering streams and rivers, and to produce a map showing the solid structure of the ground without the mantle of boulder-clay and gravel. The conclusions at which Mr. Holmes arrived were not those to which Mr. Aveline and the late Sir Andrew Ramsay could agree; and in consequence the 'solid' edition of the map, when published, did not in many important respects coincide with the views of Mr. Holmes. In the present Memoir he very clearly states the evidence obtained; and it is interesting to read (in the Director-General's preface) that "In the Carlisle region, as in Devonshire, no definite plane of separation can be satisfactorily traced between the Permian and the Triassic formations." These red rocks include the St. Bees Sandstone Gypseous Shales, Kirklinton Sandstone, and Stanwix Shales. No traces of Rhætic beds have been discovered, but there is an interesting outlier of Lower Lias. The various superficial deposits are described, and some account is given of the Solway Moss, and of its bursting in 1771.

III.—The Geology of the Borders of the Wash: including Boston and Hunstanton. By W. Whitaker, F.R.S., and A. J. Jukes-Browne, F.G.S. 8vo; pp. vii, 146. (London: printed for H.M. Stationery Office, 1899. Price 3*s.*)

THIS Memoir, which is an Explanation of Sheet 69 of the (old series) Geological Survey Map, contains an account of the geology of portions of the Fenland in Lincolnshire and Norfolk, and of the more interesting region of Lower Greensand, Gault, Red

Chalk, and White Chalk in West Norfolk. So far as Norfolk is concerned this Memoir completes the description of that county by the Geological Survey, and it contains a Bibliography supplementary to that published in "The Geology of the Country around Norwich" (1881). In the work before us we have the benefit of some recent observations on the Lower Greensand, made by Mr. G. W. Lamplugh, who has added much to the knowledge gained by his colleagues and by geologists who preceded them. He divides the formations into—

	Approximate Correlations.
Carstone	= Folkestone, Sandgate, and Hythe Beds.
Snettisham Beds	= Tealby Limestone.
Sandringham Sands	= Tealby Clay.

It is interesting to note that Mr. Lamplugh believes that the Sandringham Sands, as a whole, are newer than the Spilsby Sandstone.

Much of the information with regard to the Gault and Red Chalk, and also of the Lower and Middle Chalk, has been previously published by Messrs. Jukes-Browne and William Hill. It is, however, useful to have the information brought together in a handy form, especially in connection with the classic regions of Hunstanton. The detailed information on the Glacial Drifts and superficial deposits contains much new matter, and there are appended the records of numerous well-sections in Norfolk and Lincolnshire.

REPORTS AND PROCEEDINGS.

Geological Society of London.

I.—March 22, 1899.—W. Whitaker, B.A., F.R.S., President, in the Chair. The following communications were read:—

1. "Relations of the Chalk and Drift in Möen and Rügen." By Professor T. G. Bonney, D.Sc., LL.D., F.R.S., F.G.S., and the Rev. Edwin Hill, M.A., F.G.S.

These two islands are separated in a north-westerly to south-easterly direction by about 35 miles of sea. They both exhibit at many spots the Chalk and Drift, in relations which are peculiar and abnormal. Some geologists maintain that the glacial beds have been included in the Chalk by a series of acute folds; others, that they have been dropped down by a series of faults; others, again, explain the relationship as the result of ice-action. Simple faulting appears to be insufficient, while it is a circumstance not easily explained by earth-movement or ice-action that the axes of the folds in the Chalk strike roughly east-north-east to west-south-west in Möen and north and south in Rügen.

The authors then describe a series of sections in Möen which lead them to the following conclusions:—

(*a*) The Chalk dominates greatly over the Clay, the latter being often merely a local phenomenon.

(*b*) The Chalk is stained brown, and the Clay streaked with chalk for a few inches from the junction.

(*c*) The Clay is often a mere facing to the Chalk, or occupies semi-cylindrical or wedge-shaped cavities, which sometimes seem to terminate above sea-level.

(*d*) The Clay seems often associated with superficial ravines, which are probably never much prolonged below the sea-level. The Chalk is strongly folded, but rarely, if ever faulted, and there is no evidence to connect the intercalations of Drift with faults.

Numerous sections in Rügen are then described, which (though there are differences in detail) present a general resemblance to those in Möen, and as a rule have no resemblance to those near Cromer. After discussing and rejecting the hypotheses (faulting or folding and the thrust of an ice-sheet) which at present apparently occupy the field, the authors point out that any satisfactory theory must be in accordance with the following facts:—(1) The tripartite and generally orderly arrangement of the Drift (Rügen only); (2) the frequent unconformity of the Drift with the Chalk; (3) the occurrence of valleys or clefts in the Chalk; and (4) the variations in inclination of the Drift-beds, without the loss of their general evenness of bedding. If, at the beginning of the Glacial period, the surfaces of the islands had assumed nearly their present outlines, they may have become permanently covered with snow without the formation of glaciers. Drift might have been deposited on this frozen surface—first clay, next sand, and then another clay. When the climate ameliorated, the more or less frozen Drift would settle down, as the snow underneath it melted, warping and twisting over the crags and projections of the Chalk surface, moulding itself into the depressions, and dropping into the pipe-like hollows, as the snow and ice below gave way.

The authors abstain from discussing the physical conditions under which the Drifts accumulated.

2. "A Critical Junction in the County of Tyrone." By Professor Grenville A. J. Cole, F.G.S.

The investigations of the author have led him to the conclusion that the granite of Eastern Tyrone is identical with that of Slieve Gallion. In the Memoir of the Geological Survey it is shown that the Lower Carboniferous beds near Moneymore are full of fragments of the former granite, while it is considered that the Devonian grits at Aghnacreggan are "vitrified and turned into quartzite" at the junction. The 'quartzite' appears to be fine-grained yellowish granite, while the Devonian rocks exposed by excavation at the junction are mainly made up of large and small fragments derived from the granite. The granite is therefore of pre-Devonian age, and may be linked with those of Cavan and other parts of Ireland which are connected with the 'Caledonian' epoch of mountain-building; but it is possibly even pre-Ordovician.

II.—April 12, 1899.—W. Whitaker, B.A., F.R.S., President, in the Chair.

Mr. A. M. Davies, in exhibiting a specimen of glauconitic limestone from the Kimeridge Clay, said that it might easily be taken for Upper Greensand. It came from a road-cutting near Wombwell's Farm, Chilton (Bucks), about 40 feet below the top of the Hartwell Clay, and therefore evidently from the true Kimeridgian. The outcrop of the stone gives rise to a slight but distinct feature, traceable for about $\frac{1}{4}$ mile along the hillside. There are traces of fossils in the stone, but an impression of a *biplex* Ammonite was alone recognizable. No similar bed had been previously recorded from the English Kimeridgian.

The following communications were read:—

1. "Fossils in the University Museum, Oxford: I. Silurian Echinoidea and Ophiuroidea." By Prof. W. J. Sollas, M.A., LL.D., D.Sc., F.R.S.

Attention is called to the correlation of structure and function in the locomotive organs of Asterids, Ophiurids, and Echinids. In the case of the two latter, movement depends on tension directed along the tube-feet. In starfishes this tension is met by the disposition of the ambulacral ossicles in the form of an arch: in urchins by a continuous tessellation of the surface, which would only be weakened by arch-like interruptions. If, however, urchins have been evolved from an Asterid stem, they may have originally possessed arch-like ambulacral grooves, and the present plates of the ambulacra may have been subsequently acquired. In *Palæodiscus ferox* of the Lower Ludlow, Leintwardine, which by the structure of the buccal armature is definitely shown to have been an Echinid, the ambulacra possess just such characters as theory anticipates: an inner arch of poriferous ambulacral plates, homologous with those of a starfish, is closed externally by a series of paired plates, which represent the ambulacral series of an urchin.

The undoubted Asteroid affinities of the urchin lead to an attempt to find homologies for the elements of 'Aristotle's Lantern': the pyramids are regarded as equivalent to the first pair of adambulacral plates, the epiphyses to the corresponding pair of ambulacral plates of the Echinoid series, and the teeth are compared to the Asteroid odontophore, which has acquired a persistent root.

A new genus assigned to the Echinida is characterized by the excessively numerous minute plates which form the interambulacra. Reference is made to *Echinocystis pomum*, Wyv. Thomson; and to a species of *Protocidaris*, Whidborne, from Lower Ludlow beds, which seems to be identical with the type-species found in Devonian rocks.

The results are given of a re-examination of the unique specimen on which Dr. H. Woodward founded the genus *Eucladia*. The author agrees with Dr. Woodward in regarding the exposed surface of this fossil as ventral; it bears the buccal armature and madreporite,

and gives origin to the arms. On slicing two of the arms, no plates were exposed which it was possible to certainly identify with vertebral ossicles. Some hollow casts, from the Lower Ludlow of Leintwardine, which have hitherto been regarded as too problematical for determination, are shown to represent an organism closely allied to *Eucladia*, and are provisionally referred to that genus. The number of arms in this new species is less than in the original (*E. Johnsoni*), and they are more nearly equal in size. A new genus, closely allied to *Eucladia*, is founded on a small, well-preserved specimen from the Wenlock Limestone of Croft Farm. In this the pairs of arms or each paired series are only two in number, while in the new species of *Eucladia* at least four, and in *E. Johnsoni* as many as seven, are present. *Eucladia* and the new genus are regarded as aberrant Ophiurids, and are placed in a new order as a group of the same value as the Euryalæ. They are defined as Ophiurida possessing paired series of arms, covered externally by imbricating plates, but devoid of ambulacral ossicles. The buccal armature is abnormal.

2. "Note on the Occurrence of Sponge-spicules in the Carboniferous Limestone of Derbyshire." By Prof. W. J. Sollas, M.A., LL.D., D.Sc., F.R.S.

Remains of sponge-spicules are fairly abundant in a rock-slice taken from a specimen obtained by Mr. H. H. Arnold-Bemrose from Tissington cutting. They present themselves as sections through long cylindrical rods, but the terminations are obscure and indefinite, and the form cannot be referred with certainty to any recognized order of Sponges. The spicules were doubtless originally siliceous, but they are now completely transformed into carbonate of lime. Rhombohedra of calcite appear to have completed their growth as readily within the spicule as outside it, and the final result of the corrosion is to entirely replace the opal of the spicule by a congeries of minute crystals of calcite. As the crystals may have begun their growth outside the spicule, the latter rarely preserves its characteristic regular outlines. The crystals being frequently bounded by impurities of the limestone, the spicules are often as clearly defined as corresponding structures in the Chalk.

3. "On Spinel and Forsterite from the Glenelg Limestone." By C. T. Clough, Esq., M.A., F.G.S., and Dr. W. Pollard, M.A., F.G.S. (Communicated by permission of the Director-General of H.M. Geological Survey.)

The paper opens with an account of previous literature on the subject of minerals in the Glenelg limestone. Neither forsterite nor true spinel has been previously recorded from the limestone or from Scotland at all. The three or four bands of limestone which make their appearance on Sheets 123 and 127 of the 6-inch survey of Ross-shire are probably the same bed repeated by isoclinal folds. The banded gneisses, schists, and eclogites among which the limestones occur are separated from the sheared and inverted Torridonian rocks on the west-north-west by flaggy granulitic quartzite

and siliceous mylonite, the latter being next to the Torridonian rocks and lying along the line of a great post-Cambrian thrust, traceable from Oronsay to near the Point of Sleat. On the eastern side of the mylonite all the rocks of sedimentary aspect are greatly altered, and the gneisses and schists associated with the limestone resemble parts of the Lewisian gneiss. The quartzite-series is repeatedly folded with the gneissose series; but although the precise relationship of the two has not been made out, rocks of different characters lie next to the quartzite in different places, while the alteration-products which characterize the limestone are found in contact with the quartzite at one or two spots. In the limestone, pieces of diopside and a serpentine-like mineral are so abundant that they may equal the rest of the rock in quantity. The mass of the limestone is but little affected by movement, thus offering a strong contrast to the Loch Maree limestone. The forsterite and spinel are in part associated together in lumps, from which they were separated by means of heavy solutions for analysis. The spinel in hand-specimens is of an almost opaque blue colour, and some examples show small crystal-faces. That seen in microscopic slides is shapeless and colourless, except that the blue portions appear brown by transmitted light. Analyses of the two minerals are given at the close of the paper; and it is pointed out that the spinel is like that of Åker in colour and mode of occurrence.

III.—April 26, 1899.—W. Whitaker, B.A., F.R.S., President, in the Chair. The following communications were read:—

1. "On Limestone-Knolls in the Craven District of Yorkshire and elsewhere." By J. E. Marr, Esq., M.A., F.R.S., F.G.S.

The author begins with a general account of the district, partly founded on the published work of Mr. R. H. Tiddeman, but substantiated by his own observations. The Lower Carboniferous rocks north of the Craven Fault-system differ in character and thickness from those on the south; they exhibit little disturbance on the north, but on the south they are thrown into a series of folds, while it is also on this side that the knobs of limestone called knoll-reefs by Mr. Tiddeman occur. In order to illustrate the nature of the disturbances south of the Craven Faults, the folds of Draughton Quarry are described in detail. In addition to the anticlines and syncline usually figured, there occurs, on the north side of the quarry, an overfolded anticline with a faulted core. One of the calcareous bands is really a limestone-breccia, which appears to have been broken by earth-movement before the rocks were folded. The top and base of the breccia and of other hard bands, together with the joint-faces, are traversed by slickensides which were horizontal before the folding. Microscopic examination of the limestones shows that they exhibit various stages in crushing with development of a ribboned structure due to movement, while the matrix in other varieties has become crystalline, as though under relief from pressure.

The limestone is squeezed into the softer shale-bands, and a thin limestone-seam which occurs in one of the principal shale-beds is frequently repeated by faulting, and in one case is heaped up by repetition to form a miniature knoll, which possesses many of the characters of the larger knolls.

The prominent features of the knolls are the crystalline character of the limestone, the horizontality of bedding in the interior of the knolls the general parallelism of the bedding of the exterior to the contour of the knolls, and the obscurity of the bedding. Fossils, when present, are usually very perfectly preserved and undistorted; breccias are frequently found in the shales bordering the knolls and, much less commonly, in the limestone of a knoll itself. Evidence of movement in the knolls is seen in the lenticular character of the beds of limestone, in visible folded structures, the termination of lenticular beds in hooks against a divisional plane, and in the shales by the presence of a structure undistinguishable from cleavage. Dolomitized and silicified limestones are frequently associated with the knolls, and the perfection of the quartz-crystals in certain examples of the latter variety of rock suggests crystallization during relief of pressure. The breccias belong to three main types:—(1) Fragments of limestone in a matrix of similar material; (2) large nodules of black limestone enwrapped in shales; (3) various limestone fragments in a fine calcareous paste. Examples of each type are described, and each is explained as resulting from some form of earth-movement. Breccias of similar types are found to be produced out of grit fragments, and in places the grits are found to be piled together by faulting, so as to produce knolls which somewhat resemble those in the limestone.

A comparison of the deposits in both sides of the faults enables the author to suggest the following correlation of the beds:—

South Side.	North Side.
Millstone Grit.	Millstone Grit.
Bowland Shales.	Shales above Upper Scar Limestone.
Pendleside Limestone.	Upper Scar Limestone.
Shales with limestone.	Yoredale Shales with limestone.
Clitheroe Limestone.	Lower Scar Limestone.

The disparity in thickness of the limestone on the two sides will not be so marked, if the explanation of knolls given in the paper be correct. Dealing with the nature of the movements, the writer argues that the Middle Craven Fault is an overthrust from the north, and that the Limestone Series has undergone differential movements with respect to the hard Lower Palæozoic rocks beneath and the massive Millstone Grit above. The limestones have been squeezed out from under the synclines, and they have accumulated under the anticlines where the pressure was relieved. In conclusion, a number of examples of knolls are cited from other localities which show similar features, such as the limestones of Keisley, Millom, and near Dalton-in-Furness, some of the Devonian limestones near Torquay, the *Leptæna*-limestone of Dalecarlia, and the Devonian limestone of Koñeprus in Bohemia.

2. "The Limestone-Knolls below Thorpe Fell, between Skipton and Grassington in Craven." By J. R. Dakyns, Esq., M.A. (Communicated by the President.)

A band of limestone runs from Cracoe towards the north-east, folded in an anticline and dipping under shales. In several places the top of the limestone is brecciated and the overlying (Bowland) shale contains fragments of limestone. The limestone forms five abrupt conspicuous hills. The rocks in most of these hills are not bedded, and where they are bedded the dip is confusing; both in exposures outside of these and in adits inside, the limestone in some cases is amorphous and without any sign of bedding. When Mr. Tiddeman propounded his view that the limestone was originally formed in the shape of knolls or mounds, the author accepted his opinion for these particular hills. There is evidence that the surface of limestone underneath the shales is uneven. On Simon's Seat, a Millstone-Grit fell, there are swallow-holes showing that limestone is not far below; while below Thorpe Fell at least 450 feet of shales overlie the limestone. The author considers the absence of bedding in the limestone to be a very important feature; for in the country south of the North Craven Fault, though the rock is excessively contorted, its bedding has not been destroyed.

3. "On three Species of Lamellibranchs from the Carboniferous Rocks of Great Britain." By Wheelton Hind, M.D., B.S., F.R.C.S., F.G.S.

The first part of this paper describes a new species of *Anthracomya* which occurs in the North Staffordshire and Manchester Coalfields at horizons higher than that characterized by *A. Phillipsi*. The fossil is found at Etruria, Bradwell, Stoke-on-Trent, and Fallowfield. It appears to indicate a special zone of shales and *Spirorbis*-limestone about 300 feet below the Penkhull Sandstone, and to be the only molluscan form known from the zone.

A new species of *Carbonicola* is next described, partly from specimens previously supposed to be a gasteropod, a brachiopod, or even a crustacean, and partly from better-preserved specimens obtained from calcareous bands about 10 yards above the Bassey Mine Ironstone in North Staffordshire. It appears to be the latest species of this genus known, and to occur in higher beds than any other species.

Lastly, a new species of *Ctenodonta* from Penton Linns (Dumfriesshire) is described. It occurs in a marine shale below the highest limestone of the locality, in beds referred to the horizon of the Hurlet Limestone by the officers of the Geological Survey. The bed contains gasteropods, crinoids, cephalopods, etc., with *Productus giganteus*. The species has some resemblance to *C. Halli*, Barrois, found in Spain.

CORRESPONDENCE.

THE RIVER OF THE BALTIC.

Sir,—Mr. Hudleston's paper "On the Eastern Margin of the North Atlantic Basin" is so full of important facts, and so carefully thought out, that I am almost afraid to criticize even a minor detail. But in rejecting, with a note of sarcasm, the suggestion that the deep channel which runs round the southern lobe of Norway may at one time have carried off the drainage of the Baltic area (then land), because the soundings go down to 440 fathoms in the Skagerak, off Arendal, and are not more than 160 fathoms in one part west of the Naze, has he not overlooked some possibilities? Obviously "the river of the Baltic must have had some difficulty in draining towards the Atlantic under these circumstances." But have "these circumstances" always existed; in other words, are we entitled to assume (as he has tacitly done) that the present slope of the bed is the original one? Apart from that, if the channel is not a portion of an old river system—an ancient valley—what is it? If it be made by crust movements, the shape is singular, and we may fairly ask, if called upon to put away our belief, for something better as a substitute. Or would Mr. Hudleston allow it to be a valley, but draining southward? If so, what became of it, and is there any evidence of a general drainage in that direction as the Pliocene period was nearing its end? If ever the bed of the Baltic became dry land its drainage would have to go somewhere, and one or two North German rivers also would have to be accommodated. I am aware that the second set of movements in the Alpine chain greatly modified the drainage system of Europe, but I doubt whether there have been any revolutionary changes since that epoch. Assuming then, as I suppose we are justified in doing, this channel to be a Pre-Glacial feature, are we warranted in also assuming its bed to have retained its original slope and contours without any alteration? The present form is peculiar and suggestive. In Bohus Bay, almost west of Lake Wettern, is a limited area in which the soundings reach 355 fathoms (a larger one being below the 250-fathom contour), and in one place, slightly north of the latitude of Christiansand, we find 430 fathoms. The channel round the southern end of Norway (the deeper part being on that side) seems to vary from 250 to 300 fathoms. Then (north-west of the Naze) it rises for a little while to from 150 to 175 fathoms, and afterwards, till about opposite to the Sogne Fjord, it barely reaches 200 fathoms. But then it steepens steadily till off the Romsdal Fjord, where it returns to 400 fathoms. Doubtless this variation in depth is remarkable, but we must remember that if the channel be Pre-Glacial much débris must have been 'dumped' irregularly on its floor, even though it proved a barrier to the westward march of the Scandinavian ice-sheet. We must also remember that the Post-Glacial movements of recovery in Norway have been very far from uniform. There is, however, another remarkable fact which appears to have escaped my friend's notice. This basin of the Skagerak lies on the westward

prolongation of a belt which, beginning with the Gulf of Finland, runs across Sweden in a direction slightly south of west; thus including the fjord-pierced coast about Stockholm and the Lakes Malar, Wettern, and Wenern—a belt which is suggestive of special depression. May not this Skagerak basin be only a drowned lake? It is no doubt much deeper than either Wettern or Wenern, for the one is about 50 fathoms at most, and the other is shallower, about 20 fathoms; but making some allowance for débris, not a deeper basin than the Lake of Geneva. Mr. Hudleston seems to admit that the deeper part of St. George's Channel may be a drowned river-valley, but the slope of this, if I remember rightly, exhibits some anomalies, which, though on a minor scale, seem best explained by a certain amount of differential movement in the earth's crust. That such movements have occurred comparatively late in geological times, would, I suppose, now be generally admitted.

T. G. Bonney.

OBITUARY.

PROFESSOR SIR FREDERICK McCOY, K.C.M.G., M.A., D.Sc. (CANTAB), F.R.S., F.G.S.

Born 1823. Died May 16, 1899.

It is with deep regret we have to record the loss of another accomplished Naturalist, Geologist, and Palæontologist, belonging really to the first half of the present century, but who has survived almost to its close. The cable announcement appeared in the London daily newspapers of May 18, of the decease of Sir Frederick McCoy, Professor of Natural Science in the University of Melbourne, Australia, in his 76th year. His last communication to the Geological Magazine appeared in the May Number, p. 193. Professor McCoy was the acknowledged chief of the scientific world of Australasia, where his name and fame will be perpetuated by the splendid Museum of Natural History and Geology in Melbourne, of which he was the founder and lifelong presiding genius.

Frederick McCoy was the son of Dr. Simon McCoy, M.D., of Dublin, and was born in that city in the year 1823. He was educated originally for the medical profession, and attended lectures, hospital practice, etc., in Dublin and also in Cambridge; but while yet too young to be admitted to the profession he devoted himself assiduously to the study of all branches of Natural Science, classifying the collections of the Geological and Royal Societies of Dublin, with the object of applying recent Zoology to Palæontology as the basis of stratigraphical geology. About this time he accepted the offer of Sir Richard Griffith to make the palæontological investigations required for the Geological Map of Ireland for the Boundary Survey, publishing the results in a large quarto volume in 1844, with numerous plates including figures of several hundred new species of fossils, entitled "Synopsis of the Carboniferous Limestone Fossils of Ireland," and a smaller work in 1846, "Synopsis of the Silurian Fossils of Ireland." He was then invited by Colonel Sir Henry

James, R.E., and Sir Henry de la Beche to join the Imperial Survey of Ireland, just then commenced, and after completing the maps of the districts surveyed by him in the field, he was appointed by Sir Robert Peel's Government as one of the first Professors of the Queen's University in Ireland, the Chair of Geology and Mineralogy in the Northern College being assigned to him, where he lectured in the Queen's College, Belfast, and examined students in Dublin. About this time he undertook, in conjunction with Professor Sedgwick, the large work on British Palæozoic Rocks and Fossils, based on the materials in the Woodwardian Museum at Cambridge, and to make the critical examination of the great series of fossils of the older formations brought together by Sedgwick; the results of these labours being deemed worthy of the compliment of publication by the Syndics of the University Press of Cambridge, in a large quarto volume, with numerous plates of new fossils from the Carboniferous, Devonian, Silurian, and Cambrian formations, which was issued in 1852, as the second volume of a proposed joint work (but the first volume, which was to have comprised the Rocks, by Professor Sedgwick, was never published), entitled "British Palæozoic Rocks and Fossils," by Professors Sedgwick and McCoy.

Professor McCoy was then appointed by Sir J. Herschel and the Astronomer Royal, Sir G. B. Airy, as the first Professor of Natural Science in the University of Melbourne, where, having taken part in the formation of the University, he lectured on Chemistry, Mineralogy, Botany, Comparative Anatomy, Zoology, Geology, and Palæontology, for upwards of thirty years. He also established the National Museum of Natural History and Geology in Melbourne, of which he was Director to the last, raising it to a distinguished position, not only by the extent of the collections but also by the perfection of their classification. He was Chairman of the first Royal Commission on the Gold-Fields of Victoria; Member from the first of the Royal Commission on Technological Instruction; Member of the Royal Commission on Education; Member of the various Royal Commissions for International and Intercolonial Exhibitions for the Colony of Victoria. He was appointed Government Palæontologist at an early stage of the Geological Survey, determining the ages of the various tracts published on the Maps.[1] For over thirty years he prepared, and continued to publish in decades at short intervals, two works for the Government of Victoria, one entitled "Prodromus of the Zoology of Victoria," with coloured figures from the life, and another, "Prodromus of Palæontology of Victoria." He was a Justice of the Peace for Victoria. He was elected a Fellow of the Royal Society of London in 1880, and was created one of the first Doctors in Science, *honoris causâ*, by the University of Cambridge. The Royal University of Ireland also conferred on him their highest degree in Arts and Sciences. He was created a Knight or Chevalier of the Royal Order of the Crown of Italy by King Victor Emmanuel, and has been offered similar distinctions by other

[1] See the Life of A. R. C. Selwyn, C.B., F.R.S., in Geol. Mag., February, 1899, pp. 49–55.

foreign sovereigns in recognition of his scientific work. In 1886 he received the decoration of C.M.G. from Her Majesty, and was created a Knight Commander of the Order in 1891. He has also received the Emperor of Austria's great gold medal for Arts and Sciences, the Murchison Medal from the Geological Society of London, and other similar distinctions. He was elected one of the few (only thirty subjects of the Queen being eligible) Honorary Members of the Philosophical Society. He was an Honorary active Member of the Imperial Society of Naturalists of Moscow, and Honorary Fellow and Member of many other British and Foreign scientific bodies.[1]

The following is a list of the titles of Professor Sir Frederick McCoy's separate and smaller contributions to Natural Science; his larger works have already been mentioned in this Memoir :—

1. "Remarks on Mr. Eyton's Arrangement of the Gulls": Mag. Nat. Hist., vol. ii (1838), pp. 487–490.
2. "On a new Genus of Entomostraca (*Entomoconchus Scouleri*)": Dublin Geol. Soc. Journ., vol. ii (1839), pp. 91–94.
3. "On some new or rare Fish (*Trigla Blochii, Cottus Grœnlandicus, Thynnus Pelamys*) occurring on the Coast of Ireland": Ann. Nat. Hist., vol. vi (1841), pp. 402–8.
4. "Contributions to the Fauna of Ireland (*Vespertilio Natteveri, Tringa rufescens, Sterna leucoptera, Syrinx Forbesii, S. tenuicinctus*)": ibid., vol. xv (1845), pp. 270–4.
5. "Note on the Irish Species of Cephaloptera (Pterocephala)": ibid., vol. xix (1847), pp. 176–8.
6. "On the Fossil Botany and Zoology of the Rocks associated with the Coal of Australia": ibid., vol. xx (1847), pp. 145–157, 226–236, 298–312.
7. "On the Plants of the New South Wales and Van Diemen's Land Coalfields": Brit. Assoc. Rep., 1847, pt. ii, pp. 64, 65.
8. "On some new Fossil Fish of the Carboniferous Period": Ann. Nat. Hist., vol. ii (1848), pp. 1–10, 115–133.
9. "Reply to Sir Philip Egerton's Letter on the Placodermi": ibid., vol. ii (1848), pp. 277–280.
10. "On some new Ichthyolites from the Scotch Old Red Sandstone": ibid., vol. ii (1848), pp. 297–312.
11. "On some new Mesozoic Radiata": ibid., vol. ii (1848), pp. 397–420.
12. "On some new Genera and Species of Palæozoic Corals and Foraminifera": ibid., vol. iii (1849), pp. 1–20, 119–136.
13. "Reply to Sir Philip Egerton's Letter on the Tail of *Diplopterus*": ibid., vol. iii (1849), pp. 139–140.
14. "Reply to Professor Owen's Letter on the Ganoine of some Fish Teeth": ibid., vol. iii (1849), pp. 140–1.
15. "On some new Palæozoic Echinodermata (*Codaster*, n.g., *Perischodomus*, n.g.)": ibid., vol. iii (1849), pp. 244–254.
16. "On the Classification of some British Fossil Crustacea, with Notices of New Forms in the University Collection at Cambridge": ibid., vol. iv (1849), pp. 161–179, 330–5, 392–414.
17. "On some new Genera and Species of Silurian Radiata in the Collection of the University of Cambridge": ibid., vol. vi (1850), pp. 270–290.
18. "Descriptions of three new Devonian Zoophytes—*Stromatopora* (*Caunopora*) *verticillata, Alveolites vermicularis, Strephodes gracilis*": ibid., vol. vi (1850), pp. 377–8.
19. "On some new Silurian Radiata (*Strephodes pseudoceratites. St. trochiformis, Cœnites strigatus, Palæophora subtilis, Retepora Hisingeri*)": ibid., vol. vi (1850), pp. 474–7.
20. "On some new Silurian Mollusca (*Poterioceras ellipticum, Phragmoceras*

[1] Chiefly derived from "Men and Women of the Time," 14th edition, 1895.

intermedium, *Holopella gracilior*, *Cucullella*, n.g., *Adontopsis angustifrons*, etc.)": ibid., vol. vii (1851), pp. 45–63.

21. "Descriptions of some new Mountain Limestone Fossils (nov. gen. *Streblopteria*, *Aviculopecten*)": ibid., vol. vii (1851), pp. 167–175.

22. "On some new Protozoic Annulata (*Crossopodia lata*, *C. Scotica*, *Myrianites tenuis*, *Trachyderma lævis*)": ibid., vol. vii (1851), pp. 394–6.

23. "On some new Cambro-Silurian Fossils": ibid., vol. viii (1851), pp. 387–409.

24. "On some new Devonian Fossils (*Steganodictyum*, n.g., etc.)": ibid., vol. viii (1851), pp. 481–9.

25. "Contributions to British Palæontology: Some new Lower Palæozoic Mollusca": ibid., vol. x (1852), pp. 189–195.

26. "Contributions to British Palæontology: On some new Brachiopoda from the Carboniferous Limestone": ibid, vol. x (1852), pp. 421–9.

27. "On the Mode of Succession of the Teeth in *Cochliodus*": Brit. Assoc. Rep., 1852, pt. ii, p. 55.

28. "On some new Carboniferous Limestone Fossils": Ann. Nat. Hist., vol. xii (1853), pp. 188–197.

29. "On the supposed Fish-remains of the Silurian System": Geol. Soc. Journ., vol. ix (1853), pp. 12–15.

30. "On some new Cretaceous Crustacea": Ann. Nat. Hist., vol. xiv (1854), pp. 116–122.

31. "A Commentary on 'A Communication made by the Rev. W. B. Clarke to His Excellency Sir Henry Barkly, K.C.B., etc., on Professor McCoy's new *Tæniopteris*,' etc., etc.": Victoria Roy. Soc. Trans., vol. v (1860), pp. 96–107.

32. "Note on the Ancient and Recent Natural History of Victoria": Ann. Nat. Hist., vol. ix (1862), pp. 137–150.

33. "On the Snakes of Victoria [1861]": Victoria Roy. Soc. Trans., vol. vi (1865), pp. 7–8.

34. "On the Bones of a new gigantic Marsupial, *Diprotodon* [1861]": ibid., p. 25.

35. "Remarks on a Series of Fossils collected at Wollumbilla [1861]": ibid., pp. 42–46.

36. "On the Occurrence of *Limopsis Belcheri*, *Corbula sulcata*, and some other Recent Shells in the Fossil State in Miocene Tertiary Beds, near Melbourne": Ann. Mag. Nat. Hist., vol. xvi (1865), pp. 113, 114.

37. "Notes on the Australian Species of *Arripis*": ibid., vol. xvi (1865), pp. 187–8.

38. "Note on the Cretaceous Deposits of Australia": ibid., vol. xvi (1865), pp. 333–4.

39. "On the Canine Teeth of *Thylacoleo carnifex*, Ow.": ibid., vol. xvi (1865), p. 448.

40. "On a new Species of *Halmaturus* (*H. Wilcoxi*) from East Australia": ibid., vol. xviii (1866), pp. 322–3.

41. "On some new Species of Fossil Volutes (*V. macroptera*, *V. Hannafordi*, *V. antiscalaris*, *V. anticingulata*) from the Tertiary Beds near Melbourne": ibid., vol. xviii (1866), pp. 375–381.

42. "On the Australian Tertiary Species of *Trigonia*": Geol. Mag., Vol. III (1866), pp. 481–2.

43. "On the Discovery of Cretaceous Fossils in Australia": Victoria Roy. Soc. Trans., vol. vii (1866), pp. 49–51.

44. "On the Palæontology of Victoria (Australia)": Amer. Journ. Sci., vol. xliv (1867), pp. 279–282.

45. "On two new Species of Birds (*Pardalotus xanthopygus*, *Sphenura Broadbenti*) found in Victoria": Ann. Mag. Nat. Hist., vol. xix (1867), pp. 184–5.

46. "On the Occurrence of *Ichthyosaurus* and *Plesiosaurus* in Australia": ibid., vol. xix (1867), pp. 355–6.

47. "On the Recent Zoology and Palæontology of Victoria": ibid., vol. xx (1867), pp. 175–202.

48. "On a new Genus of Phalanger: *Gymnobelideus*": ibid., vol. xx (1867), pp. 287–8.

49. "Descriptions of two new Fossil Cowries (*Cypræa avellanoides*, *C. gigas*) characteristic of Tertiary Beds near Melbourne": ibid., vol. xx (1867), pp. 436–8.

50. "On a new Species of Victorian Honey-eater: *Ptilotis Leadbeateri*": ibid., vol. xx (1867), p. 442.
51. "On the Occurrence of the Genus *Squalodon* in the Tertiary Strata of Victoria": Geol. Mag., Vol. IV (1867), p. 145.
52. "On three new Victorian Birds: *Herodias grezetta, Sphenura Broadbenti, Pardalotus xanthopyge*": Victoria Roy. Soc. Trans., vol. viii (1867), p. 41.
53. "On the Discovery of Enaliosauria and other Cretaceous Fossils in Australia": ibid., pp. 41, 42.
54. "On the Species of Wombats": ibid., pp. 266–270.
55. "Note on the *Phascolomys setosus*, Gray, and *P. niger*, Gould": Ann. Mag. Nat. Hist., vol. i (1868), pp. 30, 31.
56. "On a new Volute: *V. Thatcheri*": ibid., p. 54.
57. "The Australian Representative of *Cynthia cardui*": ibid., p. 76.
58. "On the Fossil Eye and Teeth of the *Ichthyosaurus Australis*, McCoy, from the Cretaceous Formations of the Source of Flinder's River; and on the Palate of the *Diprotodon*, from the Tertiary Limestone of Limeburner's Point, near Geelong": Victoria Roy. Soc. Trans., vol. ix (1868), pp. 77, 78.
59. "On the Spire of *Voluta Thatcheri*": Ann. Mag. Nat. Hist., vol. iv (1869), p. 140.
60. "On a new Volute: *Voluta* (*Amoria*) *canaliculata*": ibid., vol. v (1869), p. 34.
61. "On a new Australian Species of *Thyrsites*: *T. micropus*": ibid., vol. xi (1873), pp. 338–9.
62. "Note on the Appearance in Australia of the *Danais Archippus*": ibid., vol. xi (1873), pp. 440–1.
63. "On a new *Parascyllium* from Hobson's Bay [*P. nuchalis*]": ibid., vol. xiii (1874), p. 15.
64. "On a third new Tertiary Species of *Trigonia* [*T. Howitti*]": ibid., vol. xv (1875), pp. 316–7.
65. "Note on an apparently new Parrot [*Cyclopsitta Leadbeateri*] from Cardwell, N.E. Australia": ibid., vol. xvi (1875), p. 54.
66. "On a Tertiary *Pleurotomaria* [*P. tertiaria*]": ibid., vol. xvi (1875), pp. 101–2, 235.
67. "On a new Victorian Graptolite [*Didymograpsus Thureaui*]": ibid., vol. xviii (1876), pp. 128–30.
68. "On the discovery of the *Trigonia acuticostata* (McCoy), in the living state": ibid., vol. xviii (1876), pp. 273–4.
69. "Description of a new Volute [*Voluta Roadnightæ*], from the South Coast of Australia": ibid., vol. viii (1881), pp. 88, 89.

MISCELLANEOUS.

Cambridge Honours. — On Thursday, 27th April last, the University of Cambridge conferred the honorary degree of Doctor in Science upon Professor T. Wiltshire, M.A., F.L.S., F.G.S., F.R.A.S., so many years Secretary of the Ray and Palæontographical Societies and for some years Treasurer of the Geological Society of London, Emeritus Professor of King's College, London. The following was the speech delivered by the Public Orator in presenting Professor Wiltshire for the honorary degree of Doctor in Science:—"Unus ex alumnis nostris, societatis geologicae, astronomicae, Linnaeanae socius, idcirco praesertim inter peritos laudatur, quod palaeontographicae societatis in usum, palaeontologiae studiosorum ad fructum, aevi prioris monumenta a rerum natura in saxis impressa, non sine summo ingenio et labore illustrata, per annos plurimos litterarum monumentis mandaverit. Idem Universitatem nostram beneficio singulari ad sese devinxit, quod non modo bibliothecam suam, sed etiam vitae antiquae reliquias veteres in saxis conservatas et saxorum inter se diversorum exempla quam

plurima, nuper nobis in perpetuum donavit. Illa vero exempla omnia, olim inter Londinienses in Collegio Regali professor, docendi praesertim in commodum collegerat, cum Horatio (ut videtur) arbitratus 'demissa per aurem quam quae sunt oculis subjecta' animum segnius excitare. Etiam ipsa fama liberalitatis tantae nuper inter nosmet ipsos inter rerum naturae praesertim studiosos animum gratum excitavit. Quanto magis juvat Universitatem totam liberalitatis tantae auctorem ipsum hodie oculis suis redditum et auspiciis optimis praesentem contemplari. Qui prioris aevi tot exempla nobis donavit, ipse nostro in saeculo munificentiae in Universitatem nostram ab aliis imitandum praebuit exemplum. Praesento vobis geologiae professorem emeritum, virum de rerum naturae studiis praeclare meritum, Thomam Wiltshire."

Testimonials to Professor T. Wiltshire, M.A., D.Sc., F.L.S., F.G.S., F.R.A.S., etc.—The President of the Palæontographical Society announces that a Committee has been formed consisting of present and past officers, members of Council, subscribers to the Palæontographical Society, and contributors to its publications, for the purpose of raising a testimonial to be presented to their valued Secretary, the Rev. Professor T. Wiltshire, M.A., F.G.S., etc., who, from 1863 to 1899, a period of 36 years, has so ably and efficiently carried on the affairs of the Society, and the issue of its annual volumes. The duties of Secretary are continuous, and at times arduous; and the Committee are of opinion that it would be well not to delay longer performing so agreeable a task as to offer Professor Wiltshire some slight recognition of the valuable services which he has rendered to palæontological science for so many years. They are anxious to make the testimonial as comprehensive as possible, and they hope to obtain the support, not only of all members of the Society, but of all who are interested in palæontology. They have therefore ventured to suggest a one-guinea subscription, without, however, debarring anyone who may desire to contribute more or less. Sir John Lubbock, Bart., has kindly consented to act as treasurer, and subscriptions may be sent, either direct by cheques to Messrs. Robarts, Lubbock, & Co., 15, Lombard Street, E.C., marked "For the Wiltshire Testimonial," or, if forwarded to Aubrey Strahan, Esq., M.A., F.G.S., the honorary secretary to the Committee, Geological Survey of England and Wales, 28, Jermyn Street, London, S.W., they will be duly acknowledged by him.—We understand that a similar wish has been expressed to recognize Professor Wiltshire's services in connection with the Ray Society, and that subscriptions are being received by John Hopkinson, Esq., F.G.S., The Grange, St. Albans, and by Sir John Lubbock, Bart. (the President of the Ray Society), as above. More than a hundred members of these Societies have already sent in their names and subscriptions, and many others will doubtless follow as soon as they are made aware of the proposal. It has been suggested that the testimonial, in part at least, should take the form of a presentation portrait, and arrangements have already been made with an able artist for carrying this object into effect as speedily as possible.